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Forest Insects

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Photo by U. S. Forest Service, 1955.

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Forest Insect Research and Control

Whiteford L. Baker

IN THIS AGE of atomic physics, space exploration, cold wars, and high cost of living, it is asking a lot of the public in general to become greatly interested or genuinely concerned over forest insects and their control. It is hard for most people, even when they are told the facts, to realize that these insects which have been with us so long are so important to their welfare. A major reason for this probably is that insects are so much a part of the natural scene that few people notice them or are concerned about them, unless they happen to run afoul of those that bite or sting. Furthermore, forest insect infestations are even less often seen and their effects are seldom recognized for what they are.

Few indeed are the people who realize the enormity of the loss caused by insects to the forest resources of this, or any other country. How adequately to educate the public to the magnitude of these losses, and how to stir it into action in doing something to prevent or reduce them, is a major challenge facing conservation-minded people everywhere. Fortunately, there are signs of growing concern on the part of more and more people over these losses and what to do about them. Increasing timber values and wider utilization of forest products of all kinds are causing these losses to be felt where they hurt the most—in the nation's pocket book. As we move on towards the next century still more people are going to become interested. This will happen because the forest insect problem, far from lessening, will continue to increase along with increasing values of the resources at stake.

This symposium on forest insects is not directed so much at the public in general as it is at a more select group. It is presumed that members of this group, the readers of the JOURNAL OF FORESTRY, are interested in the subject and are familiar with many of its aspects. They know from direct experience, or from their reading, of the tremendous timber losses caused during insect outbreaks. They have heard that insects kill enough timber each year in this country alone to build 600,000 five-room houses; also that they kill one fourth as much pulpwood as is consumed each year in the manufacture of the nation's newsprint.

They have heard that the totality of loss caused by insects is still much greater than this; that added losses are caused by insect infestations which do not kill trees outright, but which lead to reductions in their growth; to the stunting and deformations of trees; to lumber degrade; to upsets in management practices; and so on. They have seen estimates of the extent of insect-caused losses in our forests; but in looking at the figures they may not have realized how conservative they really are. As a matter of fact, damages caused by a host of other insects, some of which occur in enormous numbers at times, are not included in these estimates at all. No one knows or can reasonably estimate how much damage they cause.

Thus, it is assumed that the readers of the JOURNAL are fairly well familiar with the nature and magnitude of the forest insect problem, and its importance. However, it is not likely that knowledge as to where we stand in research and control of forest insects is equally widespread, or as well understood. It is to be hoped that this symposium will serve to rectify this situation to a considerable degree.

Forest entomologists in this country and Canada, working quietly and often with a minimum of equipment and facilities, have learned a lot about forest insects. They have determined the biologies, distribution, and host relationships of many of the major pest species in each country; and have developed materials, methods, and equipment for use in suppressing outbreaks of many of them. This has been a man-sized job and has taken years to accomplish.

Would that we could say the job is finished. Unfortunately, we cannot. Every year, in fact, news pests pop up here and there in our forests, or old ones break out in different regions. This often calls for new or broadened studies of life histories, habits, damages caused, host relationships, and methods of control. Sometimes, of course, the results of previous research on closely allied species can be brought to bear on these insects, but not always. As forest entomologists see it, this sort of thing will continue for a long time to come.

Indeed, a lot of work has already been done, and a lot is being done, to lessen the impact of insects on our forest resources. One of the challenges facing us now is to make the most of what we already know and to utilize to the fullest extent possible the control techniques which have already been developed.

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This will call for increased interest and participation by all public and private land-managers alike.

Before it can be done to maximum advantage, however, the public will have to be better educated in the importance of the problems involved and in the necessity to do something about them. This will be no small task in itself, but it should not be an insurmountable one. The problem of teaching woods workers how to recognize important forest insects or when and where to look for abnormal infestations should not be overly difficult. Finding and reporting all abnormal infestations, before outbreaks become fully developed, followed by scientific evaluation of their significance, and then the application of control measures where needed, should alone result in greatly reduced losses.

This is not the place to go into detail concerning the steps which can be taken to reduce insect-caused losses. Others will discuss these aspects of the subject. Suffice it to say that we have come a long way in the development of direct control measures. We know how to combat outbreaks of most of our pest species more or less successfully. We know how it can be done even though we may not always know how it can be done most effectively or economically. Much more research must be conducted before answers to all of the questions will be found. Some of it is currently underway and progress is being made all along the line.

It is unfortunate that so much less is known about the prevention of outbreaks than about their suppression. A few noteworthy exceptions to the contrary, the subject of outbreak prevention is mostly a closed book. Unless and until a lot more is learned about it and how to put the knowledge to use, we will continue to be faced with outbreaks here, there, and everywhere in our forests.

In order to learn what needs to be known, more long-term research will be required than it has ever been possible to undertake in the past. To put it mildly, what we are up against here is learning what causes insect outbreaks. This is going to be a tough nut to crack. It calls for much greater emphasis on basic research, both in the laboratory and in the woods. Needless to say, insects are affected by many environmental factors, working alone or in combinations, and different species react to them in different ways. Factors which operate to trigger off an outbreak of one may have little or no measurable effect on another. Each species comprises a unique problem in itself. The habits and behavior of no two are alike, even though those of many closely related ones may be broadly similar.

While it is known that blowdowns may set the stage for explosive populations of certain species, it is also known that they do not do so for others. Drought conditions also set the stage for outbreaks of some species, but not of all. Stand densities, the age of trees, site conditions, climate, and biological factors are involved in outbreaks of many species, but seldom in the same way or to the same extent in any two. Generally speaking, insect parasites, predators, and diseases are thought to be among the more important controlling factors affecting insect populations. There is a vast array of these whose members and control effectiveness wax and wane through the years. Learning more about these natural enemies of destructive insects, and how to obtain maximum benefits from them, is another challenge of the future.

Generally speaking, quite a bit of research is already underway on the causes of insect outbreaks in this country and Canada and progress is being made. As a result of knowledge already accumulated it is now possible to recommend the use of certain management practices to lessen the chances of damaging populations of some species from developing. However, what has been learned is but a drop in the bucket compared to what needs to be known. Such knowledge is prerequisite to the development on a wide-scale of preventive control methods.

In summary, let it be said that there is much that can be done now to reduce the losses caused by forest insects, and the outlines of what needs to be done to make our efforts still more effective in the future are fairly well discernible.

Utilizing all available weapons, it should be possible to set up reasonably effective holding actions against most of our current major pest species until such time as it is possible to bring to bear the fruits of an intensified and expanded program of research in preventive control. This means that for many years to come the only recourse will be to continue to combat outbreaks of most of our destructive species.

There will not be much that can be done to prevent them. Because of this, efforts must be continued to improve control techniques, and to insure that they are always the best ones to apply.

In the future, moreover, we must always remain alert to the fact that our forest resource is not comprised of timber alone and that other values must also be preserved. In protecting the one we must make certain that we are not unduly jeopardizing the existence of another. All factors of loss against gain must be continually weighed and the general public must be kept informed that this is being done to the limits of current scientific knowledge. Forest entomologists are aware of these needs and can be expected to give them due consideration as they continue to strive for better means of protection of our forests from insects in the coming years.

Every Forester Has a Stake in Forest Insect Spraying

Warren V. Benedict

JUDGING BY THE AVALANCHE of publicity given to the alleged harmful effects of insect spraying upon man and wildlife, and by the numerous resolutions passed by well-meaning organizations, American foresters are destined to find their insect control work examined and questioned more frequently by the public than ever before. Anti-spray people can be expected to sponsor legislation to curb insect spraying activities, and it will have a fair chance of becoming law unless foresters alert themselves and do a better job of informing the public about this essential work.

Most of the public is uninformed about the spraying of chemicals to control forest insects. All foresters should be fully acquainted with forest insect spraying. They should be aware of the mushrooming public reaction to it, and they should inform the public about the important place it has in forest management. If they ignore public opinion, they face the prospect of having forest management bound by curbing legislation.

Insufficient attention has been given to the benefits that result from chemicals properly applied, and to the essential position chemicals must occupy in protecting and preserving forest values. This article is aimed primarily toward explaining the circumstances and considerations surrounding the use of chemicals and the benefits that result from their use.

Losses from native insects have always occurred throughout the forests of this country and will continue to occur in limited amounts, depending upon the intensity of prevention and control measures. Intensity of these measures will in turn be governed by the values and intended uses of a particular forest tract. As values and uses become greater, control efforts can be expected to increase. Except in the case of a newly introduced insect still confined to a limited area, elimination of an established population would be extremely difficult, costly, and impractical if not impossible. Therefore a fundamental principle of control is to reduce a destructive native insect to an endemic level, or to prevent its development to an epidemic level. It is also important that control strike a favorable economic balance between cost of the work and the values of the forest resource protected.

Foresters have three basic tools for checking insect-caused losses: cultural, biological, and chemical. Each has its advantages and its limitations. All are used whenever they can best contribute to holding down losses. Aside from logging, which can be and often is used as an effective direct control method, cultural measures are basically preventive. Their role—and it is a large and important one—is in creating conditions unfavorable to insect development that keep an outbreak from occurring. Nature's checks and balances—the parasite, predator, and disease relationships—are also primarily preventive for to date we have had little success in altering the distribution and number of natural enemies of destructive native insects by artificially rearing and redistributing them. In addition to their preventive action, proper cultural measures also operate to maintain a favorable biological balance.

In spite of current cultural practices and biological controls, insects kill an estimated 5 billion board feet of timber in the United States yearly. In addition they cause an annual growth loss of some 3.6 billion board feet by killing immature trees, destroying wood, and slowing growth. These are the losses that occur every year—the so-called

FIG. 1.—Mute evidence of the destructiveness of the western pine beetle (*Dendroctonus brevicomis* Lec.) in a virgin stand of ponderosa pine. Decades will pass before the reproduction in the foreground reaches saw-timber size.

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FIG. 2.—Low-flying twin-engine spray plane applying DDT at a rate of one gallon per acre for control of the spruce budworm (*Choristoneura fumiferana* [Clem.]). By proper timing and careful application, excellent control of this serious defoliating insect has been possible.

FIG. 3.—Sixth instar larva of the spruce budworm (*Choristoneura fumiferana* [Clem.]) spinning its web on foliage prior to pupation. Aerial spraying is directed against the 4th, 5th, and 6th instars and must be completed before the larvae develop to the pupal stage.

"normal" losses. Now and then catastrophic outbreaks extract an additional heavy toll. No forester believes in growing trees to feed insects, yet since 1910 large insect epidemics have killed about 52 billion board feet of timber.

While losses in wood are impressive, it is only part of the forest insect story. Insect-killed trees increase the fire hazard and the severity of fire losses. Anyone who has fought fire in an insect-killed timber stand never forgets the fury, speed, and thoroughness with which both living and dead trees, wildlife, and fertile water-protecting humus are destroyed. Insect epidemics plus an aftermath of fire can help to cause floods; they can make a wildlife habitat untenable for years; they can help pollute streams and lakes with silt and ash to the detriment of fish and their food sources. With our population rapidly expanding and with an increasing demand for more timber, more recreation, more water, and more wildlife, we cannot afford the wastefulness caused by forest insect epidemics.

These enormous losses are not going to be stopped by chemical sprays alone. Rather, a skillful blending of cultural, biological, and chemical measures, each coordinated with the other and with resource management is the only answer to a fully effective insect-control program. Better and more effective prevention, coupled with harvesting of overripe timber, can go a long way toward checking annual losses. But when such measures fail to do an adequate job, we must rely upon chemicals.

The decision to use chemicals is not made lightly, and a thorough analysis of the insect outbreak is always made beforehand. Following detection of insect trouble, entomologists, foresters, and others concerned evaluate biological, economic, and other factors. They check on the abundance and population trends of parasites and predators of the destructive insect; they estimate damage with no control work and expected benefits from control; they consider and weigh all control steps that might be taken; they consider possible dangers to fish and other wildlife; and they estimate control costs and forest values threatened.

After evaluating all factors, chemical control is undertaken when the values sufficiently outweigh the cost of control, and when sanitation-salvage logging, silvicultural, and biological measures are ruled out. Chemicals come into play where other methods cannot do the job in time to avert serious damage to the forest. In combatting outbreaks of tree defoliators such as the spruce budworm and pine butterfly, the forester has no other choice—either he resorts to chemical spraying or he loses a forest.

Looking to the future, cultural and biological measures can be expected to play an increasing part in solving the insect problem, as research points the way to better prevention and as economic condi-

tions permit full use of the tools of silviculture and biology.

There are two ways to combat forest insects with chemicals. One is from the ground by manual or mechanical application of a formulated insecticide to the individual tree, and the other is by releasing them from low-flying aircraft. Generally speaking, ground-applied chemicals are used on bark beetles and aerial applications are used against defoliators.

Ground Applications

Once bark beetles have successfully established themselves in a tree, that tree is usually doomed. The only course is to destroy the beetles before they can emerge and attack other trees. Until a few years ago the most commonly accepted method for controlling bark beetles was to fell the infested trees and strip and burn the bark. Now, effective new chemicals dissolved in bark-penetrating oils are being used successfully to suppress beetle epidemics that would have been too costly to treat by former methods.

In 1958, some 783,500 infested trees and stumps in over 100 outbreaks in 23 states were treated with chemicals, principally benzene hexachloride and ethylene dibromide, at an average cost of $2.42 per tree. The cost of treating infested trees depends on their size, their accessibility, and whether they can be treated standing or must be felled and bucked into log lengths. Forest entomologists estimate that the treatment of each infested tree will prevent attacks on two or more other trees.

Since only the harvesting of overripe timber and stimulating the residual stand by cultural practices can correct most of the underlying causes of barkbeetle outbreaks, direct control is largely a temporary emergency treatment. Windfalls, slash, snow-broken trees, or trees weakened by fire, drought, smelter smoke, disease, or other causes are important factors that trigger bark-beetle outbreaks. In these cases there is little we can do to overcome such disturbances other than to locate the trouble and move in quickly with logging and chemical controls.

Table 1.—Forest Insect Aerial Spraying Projects in the United States, 1945-58

Insect	Period	Approximate area treated
	Years	*Acres*
Spruce budworm	1949-58	9,727,000
Douglas-fir tussock moth	1947, 1956, 1958	423,700
Pine butterfly	1954	255,400
Saratoga spittlebug	1949-58	64,000
Jackpine budworm	1957	40,600
Great Basin tent caterpillar	1950, 1954-58	25,000
Hemlock looper	1945, 1952	22,000
Sawflies	1950, 1952, 1955-58	10,500
Black-headed budworm	1957	6,400
White pine weevil	1956-57	4,500
Pine reproduction weevil	1952, 1957	3,100
Total		10,582,200

Aerial Application

It was not until the discovery of the outstanding insecticidal properties of DDT in 1943 that foresters had an effective method for combating outbreaks of defoliators. Previously, these destructive insects ran their natural course and inflicted monumental damage. Since World War II a varying assortment of airplanes, and more recently helicopters, equipped with tanks for carrying insecticide and spray equipment for applying it, have been developed. Aircraft make it possible to disperse chemical sprays over forested areas quickly and inexpensively. Speed is an essential in attacking most leaf-eating insects, because they are susceptible to the insecticide for only a short period—about 2 weeks—when they are in the larval or nymphal stage.

Costs of aerial spraying operations in 1958 averaged $0.75 per acre. Since one aerial spray treatment usually provides protection for several years, the protection cost represents but a few cents investment for each several dollars of value.

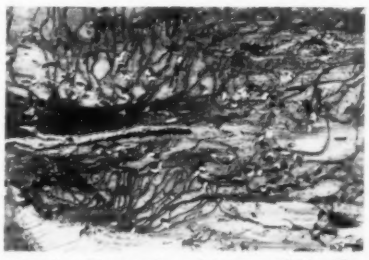

Fig. 4.—The work and larvae of the Engelmann spruce beetle (*Dendroctonus engelmanni* Hopk.) exposed upon removal of spruce bark.

Aerial spraying projects for forest insect control in the United States are currently totaling about 1½ million acres a year. Since their inception in 1947, over 10.5 million acres have been treated. The several species of insects that have been suppressed by aerial spraying and the approximate treated acreage are shown in Table 1.

Aerial spraying has been effective in reducing epidemic insect populations to endemic levels. From 95 to 99 percent of the insects were destroyed in sprayed areas, and residual populations have generally remained at low levels. Nonetheless, foresters look upon aerial spraying as a stop-gap measure to protect specific values until natural control factors again become fully operative. Some defoliator outbreaks are extremely destructive and others subside without causing appreciable damage. Therefore aerial spraying is used for the definite purpose of treating specific centers of infestations and the necessary buffer zones to prevent tree mortality and excessive growth loss.

DDT, the chemical most widely used in aerial spray work, has been intensively studied by numerous scientists for more than 15 years. In addition to the work of research teams of the Forest Service, and the Agricultural Research Service of the U. S. Department of Agriculture, state agricultural experiment stations, colleges, industrial laboratories, and others have made exhaustive studies of toxicity of DDT and other insecticides. Before being

widely used in forest spraying, the effect of DDT on fish, fish foods, and wildlife was checked by the U. S. Fish and Wildlife Service and by entomologists and other scientists of the U. S. Department of Agriculture. Those studies led to the methods now being used. It is, therefore, not without ample background that DDT has come into wide-scale use. Of course, we recognize that there is need for continuing research on the effects of DDT and other pesticides upon fish and wildlife. Additional research assistance became available on August 1, 1958, when the Magnuson-Metcalf bill (Public Law 85-582) was enacted by Congress. This law directs the Secretary of the Interior to undertake continuing studies of the effects on fish and wildlife of chemicals used for forest insect control.

Because aerial spraying is a complex undertaking with some hazard to fish and wildlife, spray projects require and receive painstaking preparation to assure the safest execution possible. It is not generally known that several months of preparation go into planning a spray operation requiring only a few weeks to perform. The more important precautions taken to minimize adverse effects of sprays on fish, wildlife, crops, and domestic animals, are:

1. Before any insecticide is applied its toxic effects are determined, and where required by state and local laws, the necessary clearances are obtained.

2. The use of insecticide is reviewed in advance with federal and state wildlife management agencies, and their views are obtained on minimizing adverse effects on fish and game populations.

3. Where there is a choice between several effective insecticides, the one least toxic to life other than insects is used, and only the lowest concentration of chemical effective on the particular insect is used.

4. Spraying is timed to catch air currents moving away from and not toward critical areas such as lakes, streams, pastures, and crop lands.

FIG. 5.—A member of an insect control crew spraying the trunk of a lodgepole pine with a formulation of ethylene dibromide to control the mountain pine beetle (*Dendroctonus monticolae* Hopk.).

5. Aerial spray equipment is accurately calibrated to discharge prescribed amounts of insecticide, and it is checked frequently to assure that the flow rate is not resulting in overdosage.

6. Spray planes are kept in good mechanical condition, not only for safety reasons, but also to avoid any need for emergency dumping of the insecticide.

7. Spray pilots are carefully briefed to avoid, to the extent possible, spraying over lakes, pastures, and residences, or paralleling large streams, when ferrying to and from airfields. Pilots are also instructed to avoid overlapping between adjoining spray blocks and spray runs, and in case emergency jettisoning of the insecticide load is necessary, to do so away from waterways, congested areas, and farmland, if possible.

8. Where respray is necessary to treat missed spots, insecticide is applied as carefully and accurately as possible to avoid respraying any area adequately covered initially.

9. Aerial observers are on constant duty during spraying operations to see that pilots are applying insecticide as instructed.

Our studies of fish damage, in cooperation with federal and state fish biologists, have resulted in rigidly tightened precautions in spraying around important fishing waters to further reduce the hazard. We recognize that all insecticides are toxic in some degree, both to insects and to other animals. Furthermore we recognize the responsibility for seeing that insecticides are applied to accomplish needed control with minimum hazard to other resources. Results of extensive experience with chemical spraying of woodlands demonstrate that when insecticides are properly applied by trained people in accord with carefully prepared plans, damage to related values will be well within tolerable limits. While spraying results have been reasonably good, they need to be made better. For this reason we are continuing our search for safer chemicals and improved ways to apply them, and for other control methods.

It is probable that insecticides in one form or another will always be needed to combat forest insects, just is insecticides continue to be essential to fully productive crop agriculture. The cotton farmer of the South, the orchardist, the sweet-corn grower, and the potato farmer stand little chance of producing a salable crop without the aid of chemicals. Commercial forest tracts also are farms, with trees the growing crop. To produce a full harvest of high-quality trees, the tree farmer must be as ready as the farmer of agricultural soils to intensively attack destructive insects. On both farm and forest, the toll of these pests can often spell the difference between profit and loss, or the serious impairment of recreation and scenic values.

In old-growth timber, use of chemical controls will decline as harvesting operations are stepped up. However, this decline will be offset by an intensification of control in second-growth stands, along with an expansion in the use of chemicals needed to combat an increasing array of troublesome insects that attack forest plantations. Also, chemical control is being used

to an increasing extent in timber sale operations to treat insect-infested trees in the sale area, and to treat stumps, cull logs, and slash that become breeding places for insects. Chemical control will also continue to be used: (1) in old-growth stands that are reserved for other than timber production, (2) in inaccessible timber, and (3) in timber that for one reason or another cannot be sold at the time an outbreak develops.

Better detection and faster suppression, under a control objective of attacking insect outbreaks in their earliest stages, will result in a sharp decline in large control projects. By the same token it will result in a big increase in small ones.

Today forest insect control is in its infancy—where fire protection was about 25 years ago. While advances have been made in the three basic approaches for checking insect losses, much more work needs to be done in strengthening and improving control methods and in developing methods for combatting those insects for which effective controls are not now known. In a coordinated program of preventive and suppressive action, chemicals can be expected to occupy a continuing important role.

We must not forget that the full impact of an unchecked forest insect epidemic is its overall effect on the community, timber, recreation, scenery, wildlife, and fish alike, plus the time required to heal the scars and restore all the forest benefits.

And while we are about it let us not ignore the very important public information job that goes with forest insect control work. Public good will is an invaluable asset to the forest manager. Keeping the public informed will go a long way toward keeping the forest manager's hands free to protect and manage his forest in accord with the best forest practices.

Fred W. Morrell (1880-1959)

Fred W. Morrell, 78, a Fellow of the Society of American Foresters, died March 8 and was buried in Alexandria, Va., his former home.

Born March 20, 1880 at Palmyra, Nebr., he received the B.S. degree from the University of Nebraska in 1902 and the M.F. degree from Iowa State College in 1906.

He began his career in the U. S. Forest Service on the Holy Cross National Forest in Colorado, in 1906, rising in 1920 to assistant district (now regional) forester, then was appointed regional forester for the Northern Rocky Mountain Region at Missoula, Mont.

Transferred to the Washington, D. C. office of the Forest Service in 1929, he was made assistant chief in charge of public relations and of state and private cooperation. With the advent of the Civilian Conservation Corps he became assistant to the director for CCC activities in the Department of Agriculture.

On his retirement from the government in 1943, he served for several years as Washington representative of the American Paper and Pulp Association.

Mr. Morrell became a Member of the Society of American Foresters in 1908 and was elected a Fellow in 1951.

Effects on Fish and Wildlife of Chemical Treatments of Large Areas

John L. George

DDT WAS TESTED as a forest insecticide for the first time only a decade and a half ago. Tests were conducted by scientists of the Division of Forest Insect Investigations, which now is a part of the U. S. Forest Service. Biologists from the U. S. Fish and Wildlife Service were invited to cooperate in determining if there were side effects on fish and wildlife populations or on their food supply (*12*). Field studies during this and later years provided the basis for recommendations for procedures that would control forest insects and at the same time safeguard wildlife populations (*4*). Since these first experiments with DDT, the numbers of pesticidal programs and chemicals used in them have increased enormously. Pesticides have been broadcast in almost all environments, from croplands to water areas. Some of these programs have been undertaken without preliminary tests to determine what effects the treatments may have on wild animals. Observations of results have shown that the effects may be far different from the effects of DDT that were found in the woodland experiments where a single application was made at the rate of one pound per acre. For example, pesticidal treatments of marsh and aquatic areas are more hazardous than treatments of forested areas, and many chemicals are more poisonous than DDT.

The general effects of DDT on fish and wildlife can be summarized briefly.

1. No serious widespread and immediate changes occur in forest populations of amphibians, reptiles, birds or mammals after a single application of one pound of DDT per acre.

2. Applications of two or more pounds of DDT per acre affect populations of most vertebrate animals; five or more pounds per acre produce serious mortality among most species.

3. Among vertebrates, mammals are the least sensitive to DDT, birds are somewhat more susceptible, and cold blooded animals are the most sensitive.

4. Most aquatic organisms are more susceptible than terrestrial forms. Some fish and shellfish mortality can be expected after a single application in excess of 0.2 pound of DDT per acre to water surfaces. When applications are repeated at weekly intervals, damage can be expected if the individual treatments exceed 0.1 pound per acre.

These facts were taken into consideration in planning subsequent large-scale programs for control of forest insects. The two most extensive of these programs, those for control of the spruce budworm and the gypsy moth, have involved treatment of about 20 million acres of forest up to the present time. Perhaps the most studied of the forest-insect control programs has been the one directed against the spruce budworm. A serious outbreak began about the time that DDT was released for civilian use. Studies of the side effects of this program have been conducted in Canada and the United States with similar results: generally little widespread effect on vertebrates was found when applications did not exceed one pound of DDT per acre. Studies of deposits of DDT on the forest floor showed that only a small part, perhaps 20 percent, of the quantity that was applied reached the ground. In certain local areas operational control difficulties led to far higher rates of treatment than were intended, and there was mortality of wildlife. In large-scale pesticidal programs, it is difficult to be sure that the treatments are carried out exactly as they are planned, but it is very important that every effort be made to insure that they are. Perhaps even more important than avoidance of local overdoses, is the necessity of keeping the chemical out of waterways.

Two Serious Die-offs of Fish

Two recent serious die-offs of fish have emphasized the importance of the above precaution. The first of these occurred during 1954 in the Miramichi River drainage in New Brunswick, Canada. A treatment of 0.5 pound of DDT per acre resulted in the loss of up to 91 percent of the young Atlantic salmon of three age groups and some adults (*19*). Salmon losses in a nearby stream that was not treated were negligible—about 2 percent. The DDT also caused very heavy reductions in populations of stream insects. Recovery in numbers of certain kinds of insects was noted the following year (*16*). The increase in midges provided food for an excellent crop of under-yearlings but small and large parr were greatly reduced in numbers (*17*). Portions of the Miramichi River drainage were treated again in 1956, with very much the same results as in 1954 (*18*).

The other serious die-off of fish occurred in the Yellowstone River in 1955. Assistant Secretary of the Interior Ross Leffler (*22*) has estimated the value of the fishery on this particular section of the Yellowstone to be $20,000 per mile per year, in terms of expenditures by fishermen. As in the Miramichi River, there was a great reduction in numbers of aquatic invertebrates. In the fall, about three months after DDT was applied at 1 pound per acre for control of the spruce budworm, large numbers of trout, whitefish and suckers, includ-

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ing many or most of the young of the year, were found dead along more than a 100-mile stretch of the stream. The loss of food organisms appears to have been serious enough to have caused the death of the fish. In the year following the treatment, 1956, there was a large hatch of young trout and fishing was good; in 1957, the recovery of bottom organisms in the drainage area was judged to be complete except in one stream.

Effects on Trout Streams

Spruce-budworm control treatment of almost one million acres on three national forests in Montana during 1956 provided an opportunity for federal and state biologists to observe the effects on aquatic life in 13 trout streams (*2*). Numbers of aquatic and terrestrial invertebrates were greatly reduced by the spray even though maximum concentration of DDT in water samples was 0.33 ppm. This maximum level was recorded one-half hour after spraying; 27 hours after spraying no measurable amount of DDT was present in the stream samples. Dead insects continued to be carried downstream for five days and trout fed freely upon them. The trout, nevertheless, did not appear to be affected, either by the toxicant or as a result of gorging upon the dead insects. Before the end of the season, some repopulation of aquatic insects began in certain of the streams. In most of the streams, recovery of insect populations continued during 1957 (*10*), and in one of two streams that were studied intensively numbers appeared to be normal by September of 1957. There was a slight decrease in numbers of trout in these two streams but live trout appeared to be in good condition despite the fact that analysis of their tissues showed that they contained DDT. Eleven other streams were studied less intensively with results that were much the same except that in two of five of these whose fish populations were checked, there were serious game-fish depletions—a loss of about 75 percent during the second year after treatment. This indicates again that long-range effects may not be apparent until the second year.

The Gypsy-Moth Program

The gypsy-moth eradication program in forests of the eastern United States has produced essentially the same effects on fish as have most operations for spruce-budworm control (*15*) except that no spectacular kills have been reported. Losses of aquatic insects have been heavy, commonly 70 to 90 percent (*14*), but large numbers of dead or dying fish have not been observed. During the widespread eradication campaign in 1957, dead fish could be counted in the hundreds or higher in only a few localities (*3*). These instances of mortality appeared to be the result of operational-control problems that led to direct application of insecticide to lakes or streams. In areas where the full spray hit the water, there was every reason to expect mortality. In localities on Long Island where spray planes passed or turned around over tidal marshes, there was considerable mortality of crabs (*3*). This was to be expected as crustaceans have been shown to be easily poisoned by DDT.

Studies of repopulation of streams by aquatic insects after treatment for gypsy moth have shown that certain populations may not return to normal, or at least not to pre-spray levels, even after a year. Blackflies, midges and certain mayflies readily reinhabited sprayed areas but the caddisflies, certain stone flies and certain may flies that are principal food items for larger trout were reduced in numbers (*13*).

In areas treated for gypsy moth control, the reptiles and amphibians also may be affected by DDT. Hoffmann and Surber (*15*) state that overall populations are not greatly affected, but aquatic forms may be eliminated from local ponds (*8*). Terrestrial forms are more resistant (*9*).

Other Programs

Rather large acreages are treated also for control of other forest pests, but none of these is as extensive as the areas covered in spruce-budworm and gypsy-moth control. Foresters in western areas often are concerned with extensive range lands where grasshoppers or Mormon crickets are abundant. During each of the past several years, millions of acres were treated for control of these pests. The usual treatments are: aldrin or heptachlor at 0.1 to 0.3 pound per acre; chlordane at 0.5 to 1.0 pound per acre; or toxaphene at 1 to 1.5 pounds per acre. The chemicals are applied as sprays for grasshopper control and in bran or wheat baits for Mormon cricket control. Although the dosages of aldrin and heptachlor are quite low, these compounds are many times more toxic to fish and wildlife than is DDT; feeding tests indicate they are from 15 to 100 times more toxic to some species. In areas where grasshoppers and Mormon crickets are a problem, there is no forest canopy to partially screen the poison, so the full dose reaches the ground. Reports indicate that mortality of certain kinds of animals can be moderate to severe, especially if aquatic habitats are treated. In prairie marshes, two ounces of aldrin per acre killed from one-sixth to one-third of the young ducks (*20, 21*). These losses apparently were the result of the birds eating contaminated foods. Other losses, of song birds, apparently were due to a shortage of food (*7*). One pound of chlordane per acre has been reported to cause a loss of one-half in the production of the marsh birds in an area (*11*). Toxaphene has caused some losses of ducks and coots at 1.5 pounds per acre (*20*), and very heavy losses of young birds at 2 pounds per acre (*11*).

Losses of fish and aquatic invertebrates have sometimes been heavy. Aldrin, heptachlor, and toxaphene all have been shown to be very potent poisons in the laboratory and in the field. Heavy kills of crayfish followed application of 0.25 pound of heptachlor per acre (*25*), and fish kills have followed applications of toxaphene that were as low as 0.1 pound per acre (*23*). Unpublished reports of observations in Montana during the sum-

mer of 1958 reveal heavy depletions of aquatic insects and disappearance of trout in some streams after treatment for grasshopper control.

Certain other control programs, such as the one for Dutch elm disease, do not involve area-wide treatments, but when all applications are totaled they amount to large acreages. It has been estimated that the equivalent of over 2,000,000 acres has been treated, if it is assumed that spraying of each elm tree affects 0.5 acre. Dosages in this type of treatment are from 2.5 to 5 pounds of DDT per tree, depending upon the type of treatment, roughly a dosage of from 5 to 10 pounds per acre. This amount is large enough to cause serious mortality in the local areas affected. Numerous recent reports in our files indicate that mortality has occurred as a result of treatments for Dutch elm disease control.

Long-Range and Other Effects

In addition to the field problems encountered in the major pesticidal programs now in operation, there are certain other factors to consider in the relationship of pesticides to wildlife. Immediate mortality of individuals is not the only cause for concern. Effects that are long-delayed still may be serious. During the past year, an important indirect effect was reported: species feeding upon earthworms died from pesticide poisoning a year after the area was treated (*1*). The earthworms, known to be resistant to DDT and capable of storing it in their tissues, continued to live while containing reservoirs of DDT sufficient to cause secondary poisoning of their predators. Studies in progress give indication that other pesticides also can be stored by resistant organisms. Few studies have been made to determine what effect this phenomenon has upon wild populations, but field reports from several localities in the midwestern United States suggest that this may be the reason why the numbers of certain birds are being reduced in local areas.

Another relatively recent finding in laboratory studies is that adult bobwhite quail and ring-necked pheasants that are fed sub-lethal amounts of pesticides may appear to be quite normal and yet be deficient in reproductive potential. Consumption of very minute amounts of several commonly used chlorinated hydrocarbons may produce these effects. Consumption by pheasants of one two-hundred-thousandths of an ounce per day for a two-month period resulted in production of eggs of reduced hatchability and of chicks subject to high death rates (*5*). Bobwhite showed the same effect when they were fed one-fifth of this amount. Penned quail whose diets contained DDT at the rate of 3 ounces per ton of food produced egges whose fertility was reduced 30 percent. When compared to quail on standard diets, they produced 33 percent fewer chicks per hen, and 800 percent more crippled chicks (*6*). More than 90 percent of the chicks from the experimental birds died within six weeks, even though the chicks themselves were fed no contaminated food. This again is a phenomenon not yet evaluated in the field.

Still another problem of widespread importance is the delayed entry of toxic materials into aquatic environments. Even though waterways may be avoided in the initial pesticide application, it is possible that rains may wash the chemicals into lakes and streams, and thus poison fish or fish food (*24*). This type of poisoning has been demonstrated by Young and Nicholson (*27*). Just how frequently it occurs is a matter of conjecture. Early studies with DDT sprays in forests showed little poisoning from this cause (*15*).

The forester should not judge the effects of all large-scale pesticidal programs on the basis of what he sees in his own work or reads about in connection with other forest-insect control programs. The problems of insect control on agricultural land often are different. For example, in the program for eradication of the imported fire ant, heptachlor or dieldrin is used at the rate of 2 pounds of technical material per acre. Laboratory studies show that these compounds are from 15 to 20 times as toxic to quail and pheasants as is DDT. Applications then are somewhat comparable to dosages of from 30 to 40 pounds of DDT per acre—many times greater than the one pound per acre considered relatively safe for wildlife in forested areas.

Losses versus Gains

In appraising the effects of pesticide use and in making decisions of when to initiate pesticidal programs, it is important to weigh losses against possible gains. Although few, if any, pesticide applications are made primarily for the benefit of wildlife, anything that prevents the widespread death of forests and the fires that probably would follow, tends to maintain forest wildlife. When forests are preserved, necessary cover is maintained, erosion is prevented, silting and warming of streams are avoided. In general, moist, moderate to cool environments are maintained in stratified layers. These conditions promote forest wildlife survival and abundance.

Problems of multiple use of resources are not new to the forest conservationist, who first promulgated the idea of multiple use. Forest management, however, sometimes seems to lead to multiple conflict when various interests insist on different uses of a given area or resource. Decisions will have to be made for particular areas, but in so doing the economic value of wildlife and wilderness resources should not be underestimated. A survey made by Crossley S—D Surveys, Inc. for the U. S. Fish and Wildlife Service in 1955 (*26*) indicated that expenditures by hunters and fishermen in that year alone were $3 billion. There were approximately 25,000,000 licensed sportsmen in that year. It is reported that over 34,000,000 licenses were sold in 1958, a gain of 36 percent in three years. There is every reason to believe that the numbers of hunters and fishermen will continue to increase rapidly and that they will want more game and fish. Another, and larger, group of Americans has a strong

aesthetic interest in wildlife. They want both game and non-game animals to continue to live under natural conditions where they can be observed and enjoyed.

The interest of the Congress of the United States in the preservation and increase of wildlife is indicated by the passage of Public Law 85-582, which specifically directs the Secretary of the Interior to undertake continuing studies of the effects of pesticides on wildlife. State and federal legislation to protect wildlife values also has increased in recent years.

Precautionary Measures

Chemical-control workers should use all available knowledge to select the toxicant, formulation, dosage, equipment, and operating procedure that will give reasonable control while inflicting a minimum of damage to fish and wildlife. At times alternative methods of control should be considered. They may be more costly, but the public generally will support a more costly but safer operation.

In addition, the Fish and Wildlife Service has recommended other protective measures that should be employed. These are listed by Cope and Springer (*3*) as follows:

1. Insect infestations should be treated before they reach upper drainage areas or before they cover large acreages so that, if damage to wildlife does occur, repopulation can proceed more quickly.

2. Careful ground-to-plane control should be provided to restrict application to intended areas, to insure even coverage and to prevent local overdosage.

3. Direct application to streams, rivers, ponds and lakes, or to sites where rapid leaching into nearby aquatic areas might occur, should be avoided unless the rate of application is of less than the toxicity equivalent to 0.2 pound of DDT in oil solution per acre. In forested areas, dosages should not exceed one pound of DDT or its equivalent per acre.

4. When an insecticide is used in an emulsion, the quantity should be reduced because of the greater toxicity of this formulation to aquatic animals.

5. Applications around the edge of lakes should be made with small planes and when wind velocity is low. Where possible, ground equipment should be used in such situations.

6. Pilots should avoid turns over streams, rivers and lakes and the use of these areas as boundaries for control operations.

7. Applications of the more toxic materials should be avoided as far as possible during the brooding period of birds.

In continuing research designed to find ways to protect wildlife populations from damage by pesticides, the wildlife biologist must try to understand more about what happens to the animals and their communities when they are exposed to chemical insecticides at various times. In these ecological investigations, the toxicity levels for different poisons in various formulations and in different environments must be determined. Cooperative studies with entomologists and other experts are necessary to determine the total, long-term consequences of applying highly toxic, highly residual substances. Only such cooperative ecological investigations of the interrelationships of the various wildlife species, their environment and food, the toxicant and the degree of exposure will answer problems like those on the Yellowstone and the Miramichi.

Summary

The history of field investigations of the effects of DDT on wildlife is reviewed briefly, from the initial studies in 1945 through the more recent studies of the effects of the large-scale programs for spruce-budworm control and gypsy-moth eradication. DDT dosages and procedures that are recommended for protection of wildlife are reviewed. Effects of aldrin, heptachlor, and toxaphene are discussed in connection with the grasshopper and Mormon cricket control programs. Delayed and indirect effects of chemical treatments are emphasized as an important current problem. Cited in this connection are fish losses in the Yellowstone and Miramichi rivers and losses of wildlife from eating earthworms a year after treatment of the area with DDT. Currently recommended procedures to safeguard wildlife in pesticidal programs are listed.

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Divisions Call For Annual Meeting Papers

Division of Forest Management

The Division of Forest Management will hold its annual meeting on November 18, in San Francisco, Calif. A morning session will be devoted to a symposium with invited speakers; an afternoon session is reserved for volunteer papers.

Any member of the Society who wishes to read a paper before the Division should send a complete title and a short abstract of the proposed paper to Donald W. Lynch, Program Chairman, 316 East Myrtle Street, Boise, Idaho. The deadline for submitting titles is June 1. The program will be formulated and notices sent to speakers by June 15.

Our Division interprets forest management broadly to include among other things the appropriate aspects of forest protection, forest engineering, and land management. Care should be taken not to cover a subject which would more properly belong in the Division of Silviculture.

The program chairman and the Executive Committee of the Division shall make the final choice of papers without regard to the order received. Because of the shortage of time and the desire to include a good cross section of subject matter, the papers should be limited to about 12 minutes, and in no case exceed 20 minutes.

This is the only call for papers that will be issued by the Forest Management Division.

DONALD W. LYNCH
Program chairman

Division of Silviculture

The annual meeting of the Division of Silviculture will be held November 17 San Francisco, Calif. It will consist of a morning and afternoon session with over half of the program reserved for volunteer papers.

All members of the Society who wish to present papers before the Division should send complete titles and a short abstract of the proposed papers, together with the name and address of the speaker and the organization he represents, on or before May 15 to the chairman, William H. Cummings, Forest Research Center, Weyerhaeuser Timber Company, Centralia, Washington.

Members who submit titles for inclusion in the program are reminded that the subject chosen should be one that belongs properly in the Division of Silviculture.

The program will be made up by the executive committee of the Division by selection of papers from among the titles submitted, without regard to order of receipt. In order to provide opportunity for as many as possible to participate in the meeting, preference will be given to papers that can be presented in 15 minutes or less. No paper that requires more than 20 minutes can be considered. Authors of papers selected for the meeting will be notified as soon as possible, but in any case by June 16. This is the only call for papers that will be issued by the Division of Silviculture.

GILBERT H. SCHUBERT
Secretary

Development of Forest Insect Research and Control in Canada

M. L. Prebble

FOREST INSECT PROBLEMS in much of the United States and Canada are basically the same, owing to similarities in climate, forest cover, and tree species. For varying distances on either side of the international boundary the same insect species frequently constitute the principal regional problems. Evidence of this is repeatedly seen in the literature, and in the international work conferences of American and Canadian forest entomologists in the eastern, central, and western parts of North America. But there are differences in the organization of forest entomology in the two countries, partly traceable, I believe, to different patterns of forest ownership and administration, and to different levels of exploitation and management. Therefore, it seems equally important to trace the background and developmental history of forest entomology in Canada as to outline current programs. For those readers who may wish further detailed information, a number of references are cited; and extensive series of reprints are available on request.

The forests of Canada occupy about 1.6 million square miles, nearly one-half of the total land area. Forested land predominates in all regions except the Province of Prince Edward Island, which is preponderantly agricultural, and the Yukon and Northwest Territories, which include large areas of tundra. In all regions except the Maritime Provinces substantial fractions of the forested area are inaccessible or nonproductive. Accessible productive forests constitute but 40 percent of the total forest area.

Privately owned forest land comprises about 5 percent of the national total; the figure rises to about 10 percent if productive forest land only is considered. The percentage varies from region to region and is substantially higher in the Maritime Provinces than elsewhere. Ownership of the remaining forest land is vested in the Crown (i.e. the people), predominantly in the right of the provinces except in the Yukon and Northwest Territories, where ownership is in the right of the federal government. Responsibility for the greater part of the productive and occupied forest land accordingly rests with the provincial governments, which have established forest services for all administrative and regulatory functions pertaining to provincial crown forests.

The volume of merchantable timber in Canada is estimated at 500 billion cubic feet. Softwoods constitute about 80 percent of the total, mature stands predominating, and spruce and balsam fir make up over half of the estimated total volume. Poplar and white birch are pre-eminent among the hardwoods. The combination of relatively few tree species and continuous forest cover over vast areas has influenced the character of major outbreaks of forest insects in Canada. For example, infestations of the European spruce sawfly in the 1930's covered all the eastern provinces westward to Ontario. Spruce budworm infestations extended, in successive periods between the late 1930's and the late 1950's, from Manitoba to New Brunswick and Nova Scotia. Recent outbreaks of the forest tent caterpillar resulted in defoliation of aspen stands in practically all provinces.

The provinces depend on the federal government to provide research services in forest entomology. Huge infestations affecting two or more provinces concurrently, the need for sustained interregional surveys and research, and the results of early biological control experiments involving extensive international cooperation as well as specialized quarantine rearing facilities, were undoubtedly important factors leading to the development of forest entomological research distinctively as a federal government service in Canada.

Development of Forest Entomological Services

Development of forest entomology started in 1909 with appointment of C. Gordon Hewitt as Dominion Entomologist in the Department of Agriculture. J. M. Swaine was appointed under Hewitt, in 1912, to work continuously on forest insects, and in 1914 the Division of Forest Insects was established as a headquarters nucleus. The affiliation of forest entomology with research interests in the Canada Department of Agriculture has persisted through various reorganizations and corresponding changes in title. Swaine continued his leadership until 1934; J. J. de Gryse headed the Division from 1934 to 1952, and was succeeded by M. L. Prebble.

The early work program included surveys of infestations and damage, ecological and taxonomic studies, and consultative services pertaining to bark beetle control operations. One of the first biological control experiments in Canada was the introduction of *Mesoleius tenthredinis* against the larch sawfly in 1910 to 1913. Aircraft were first used in forest insect surveys in 1920, and in dusting operations against forest defoliators in 1927. Decentralization began in 1919 with establishment of the Vernon laboratory in British Columbia. Two other regional laboratories were set in operation in 1923, and two more in 1937 and 1940. The process was accelerated after the last war, five additional laboratories being set up by 1952. Im-

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provements in laboratory and field facilities for research and increases in staff and funds were made concurrently.

Seasonal surveys of the European spruce sawfly, carried out cooperatively with the provincial forest services and the industry in eastern Canada in 1930 and 1931, were the first phase in a process leading in 1936 to the Forest Insect Survey as a continuing project of the Division. Centered at first in Ottawa, units of the survey were established at Fredericton and Vernon in 1937, and subsequently in other parts of Canada as the regional laboratories were set in operation. A further major development in the organization of the Division was the establishment, in 1950, of "sections," exempt from any administrative or territorial responsibility, to carry out basic research in cytology and genetics, insect pathology, bioclimatology, and chemical control.

The most recent change was the amalgamation, in 1951, of the hitherto separate forest insect and forest disease research units of the Department of Agriculture, to form the Forest Biology Division, to ensure integration of the research and survey programs in these related fields. Divisional staff currently engaged on forest insect surveys and research comprises 115 research officers, 138 forest biology rangers and technicians, and 107 seasonal assistants, exclusive of clerical and maintenance staff. This group is distributed among nine regional laboratories, four sections, and divisional headquarters in Ottawa.

The primary function of the division is to conduct research and comprehensive surveys on forest insects and diseases, with the ultimate aim that timber losses may be reduced. An important contingent function is to provide technical and advisory services in connection with appraisal of damage and hazard, direct control operations, and other practical applications of research results. Divisional officers cooperate with provincial and industrial representatives in technical planning for direct control operations, and carry out short- and long-term biological studies in treated and untreated areas as a means of assessing results (*5, 6, 24, 25*).

Under the policy of decentralization these functions are discharged by the regional laboratories, which are responsible for research, surveys, and liaison with provincial forest services and the industry, within their assigned territories. Research projects in specialized fields, in which regional contacts are of minor importance, are carried out by the four sections. The principal functions of Division headquarters are program planning and coordination, editorial services, general administration of the Division, and development of general cooperative arrangements with other research organizations and administration units.

Principal Contributions of Other Organizations

Several other units within the Research Branch of the Canada Department of Agriculture contribute materially to the program of the Forest Biology Division. For example, the Entomology Research Institute provides authoritative identifications of insects recovered in the survey and in field investigative projects. In biological control experiments, the Biological Control Research Institute contracts for the collection of insect parasites and predators, through resident entomologists in foreign countries or through the Commonwealth Institute of Biological Control, and receives shipments from abroad under quarantine at Belleville, preparatory to rearing and ultimate liberation in Canada. The Statistical Research and Service Unit provides advice and research collaboration in intricate problems of population sampling and analytical procedures.

The Federal Forestry Branch of the Department of Northern Affairs and National Resources and the provincial forest services cooperate extensively in insect surveys, certain forest insect research projects, and in direct control operations. Cooperative arrangements in Ontario are unique among the provinces. Under the terms of an agreement between the Ontario Department of Lands and Forests and the Canada Department of Agriculture, the former department constructed the Forest Insect Laboratory at Sault Ste. Marie, and the latter department provided staff, equipment, and funds for its operation. The original agreement designed specifically to promote forest insect research and control in Ontario, was subsequently broadened to include forest pathology. In consequence, the Forest Pathology Laboratory at Maple was constructed by the Department of Lands and Forests, and similarly operated by the Department of Agriculture. Both laboratories serve as regional laboratories of the Forest Biology Division for Ontario, and come under the general guidance of an advisory committee representing the Forest Biology Division and the Department of Lands and Forests.

The principal role of the universities in forest entomology in Canada is in the training of research personnel, who are drawn, often initially as seasonal assistants in their undergraduate years, from the zoology as well as the forestry departments of numerous universities. A limited amount of research in forest entomology or closely related fields is carried out by university staff members with financial support of the universities, the National Research Council, or other research foundations. Another form of support is available through extra-mural research grants by the Canada Department of Agriculture. These grants are designed to encourage research on problems related to departmental projects, but which, owing to specialized research experience or facilities, can be more effectively done at a university than in a departmental laboratory. Many such extra-mural research projects have been in operation at Canadian universities in recent years, including several sponsored by the Forest Biology Division in tree physiology, forest site classification, and the application of serological tech-

niques to the study of insect predation.

The forest industries have made notable contributions to the development of forest entomology in Canada. In the field of education, industry support was instrumental in establishing chairs of forest entomology at Canadian universities, and a number of scholarships open to undergraduate and post-graduate students in entomology were set up by trade associations. Early growth of the Forest Insect Survey was made possible by active participation and assistance of industry personnel. These are still an important feature of the survey, especially in large-scale programs of mapping and hazard rating pertaining to control projects, wherein industry provides substantial proportions of the required personnel and facilities. Among various forms of support of forest insect research made by the industry, probably the most significant has been the reservation of blocks of forest land for long-term ecological studies. The industry has been dominant in the organization and execution of direct control projects, and in arranging financial participation of the provincial and federal governments.

Forest Insect Surveys and Research

The Forest Insect Survey operates from nine regional laboratories and engages the full-time efforts of 20 research officers, 20 laboratory technicians, and 70 forest biology rangers. Additional assistants are employed seasonally in the extensive rearing program connected with the many thousands of insect samples collected each year. The primary objective is detection of insect outbreaks and maintenance of an annual census of forest insect conditions throughout Canada. Division headquarters coordinates objectives and results on a national basis. The laboratories prepare reports in some detail for the use of the regional cooperators, and publish summaries for Canada in the Annual Report of the Forest Insect and Disease Survey.

From the beginning, it was expected that the objectives of the survey could be extended to include scientific as well as economic purposes (*8, 9*). Opportunities for such extension coincided with the increase in staff and improvement of facilities following the last war. Objectives were then defined to include a more comprehensive understanding of the insect fauna of Canadian forests (*14*). Toward this end, investigations of sampling systems, life histories, distributional ranges, and host-parasite relationships were undertaken by professional staff attached to the survey, with the aid of field staff capable of supplying desired material from any part of Canada. The vast accumulation of records from the field, rearing rooms, and associated identifications, is made accessible by use of a unified coding system and punch-card recording of data. Results of individual biological studies are published in scientific journals. Composite results from the survey as a whole are published as departmental bulletins (*15*).

The formation of "subject-matter" sections has stimulated research in the specialized fields. Wherever appropriate, the sections employ important pest species as research materials. This simplifies collection of samples, conduct of field trials, and integration of results in interpretation of important regional problems.

The Cytology and Genetics Section has made important contributions to the knowledge of insect chromosome behavior, phylogeny, and systematics (*23*). Recent cytological studies have been concentrated on the genera Chiloconus and Pissodes, with the cooperation of entomologists in the United States and other countries. Genetic studies have clarified the means by which integrity of the sympatric and cross-fertile spruce and jack-pine budworms is maintained and the genetic factors involved in inheritance of developmental rate and fecundity. Cyto-genetic studies of Neodiprion sawflies have recently been initiated to complement other investigations on biology and taxonomy.

The program of the Insect Pathology Laboratory[1] includes basic studies on taxonomy, development, and physiology of micro organisms affecting insects, as well as host-parasite relationships such as mode of action, histopathology, and host specificity (*7*). Ecological studies of diseases in field populations of forest insects, and experiments in biological control through the use of viruses or other pathogens, are carried out by the Insect Pathology Laboratory and by several regional laboratories. The most notable successes in biological control with pathogens have been achieved with the viruses of the European pine sawfly and the European spruce sawfly, disease being self-sustaining in populations into which it has been introduced (*3, 1*). Viruses employed against native Neodiprion sawflies have so far behaved more like selective insecticides, with little evidence of effects persisting beyond the generation in which the disease is introduced. Studies at the Fredericton laboratory of an introduced virus of the European winter moth indicate that it may be effective against certain native geometrids as well.

Investigations undertaken by the Bioclimatology Section include studies of physical factors in microhabitats, and the influence of various environmental factors on insect behavior and development (*27*). The use of synoptic methods, employed in relating climatic fluctuations to changes in abundance of the spruce budworm and forest tent caterpillar (*13, 26*), is being extended to other important forest insect problems. A recent study of general ecological significance illustrates the extent of differences in behavior among individuals of the western tent caterpillar, and the importance of these differences in the population dynamics of the species (*28*).

The Chemical Control Section

[1]The fields of interest of this laboratory, to be known as the Insect Pathology Research Institute, will be broadened to include pathology of agricultural insects, following reorganization of research groups in the Canada Department of Agriculture, April, 1959.

carries out basic studies of chemical control, and also serves in an advisory capacity. Its program of work includes studies of insecticide dispersal from aircraft, assessment of deposit in the forest, and dosage-mortality relationships involving different insecticides, formulations, and insect species (*10*). Following extensive fish mortality in large forest spraying operations, the section has collaborated with the Fisheries Research Board in comparative laboratory and field experiments of different insecticides against the spruce budworm and young salmon.

The research programs of the regional laboratories vary with the important problems of the different areas. Insects attacking conifers receive the major attention throughout Canada as a whole, with more emphasis on beetle problems in the west than elsewhere. Introduced insects are important generally, but particularly in the Maritime Provinces, Quebec, and southern Ontario. Space limitations do not permit an adequate review of research projects of regional laboratories; however, the guiding principles used in development of program can be described briefly.

1. Selection of problems for intensive study is a joint responsibility of regional laboratory heads and Division headquarters. Due consideration is given to important regional problems, gaps in existing knowledge, staff and facilities required for adequate progress, effective cooperation with other agencies, and avoidance of unnecessary duplication among different laboratories. Once staff assignments have been made, research officers are protected from distracting demands. Assignments to a specific project, or a given field of work, continue as long as commensurate advances are possible—in some cases, indefinitely.

2. Projects set up to contribute to knowledge of a specific regional problem may assume much wider significance as they develop, becoming, in effect, inter-regional or national projects. In such cases, research responsibility remains with the original regional laboratory and research officer, but with extensive support from other laboratories and headquarters in the exchange of information and materials, seasonal transfers of work to other regions, and other measures designed to increase the scope and value of the investigations.

3. Wherever possible, studies of major forest insect problems are set up as intensive ecological investigations of the interactions of the insect populations with the host tree and stand, climate, parasites, predators, and diseases. The significance of mortality factors is interpreted in terms of the population dynamics of the pest species. Progress depends on the development of statistically reliable sampling methods and analytical procedures, as well as adequate staff.

The comprehensive studies of the spruce budworm in the Green River area of New Brunswick, which have been in progress for about 14 years and engage the efforts of some six research officers and their assistants, are the most advanced among ecological investigations of insects in Canada. Designed to yield information on the possibility of reducing damage through modified management practices in the fir-spruce forest, the project has produced fundamentally important results in population dynamics and regulatory mechanisms (*18, 19, 20*). It has also contributed materially to interpretation of results of chemical control operations against the spruce budworm. Similar investigations, though of smaller proportions or shorter duration, are in progress on the balsam woolly aphid and European winter moth (Fredericton laboratory), *Neodiprion swainei* (Quebec laboratory), European pine sawfly and European pine shoot moth (Sault Ste. Marie laboratory), larch sawfly (Winnipeg laboratory), the lodgepole needle miner and mountain pine beetle (Calgary laboratory), and the Douglas-fir beetle and ambrosia beetles (Victoria laboratory).

Control

Owing to economic necessity, experiments in forest insect control, whether biological or direct, have usually preceded the fundamental studies that provide the best basis for assessing the importance of natural controls, selecting the most appropriate kinds of extraneous controls and the manner of applying them, and evaluating the results of their application (*1*). Nevertheless, vast quantities of forest wealth have been preserved by the employment of empirical methods. In the interpretation of results and their use in subsequent refinement of control procedures, it is extremely important to understand the causes of variations in pest populations in terms of the influence of indigenous and extraneous control factors (*2, 17, 21*).

Increasing concern with control of forest insects can be expected in Canada. In biological control projects the cooperative arrangements involving the several Canadian and foreign agencies are designed to lead to integration of results of ecological studies in Canada, foreign explorations, and programs for the introduction of organisms and study of biotic factors. These arrangements should prove adaptable to the needs in specific problems where biological control offers the best chance of solution.

In direct control projects, primary responsibility for organization, financing, and execution will doubtedly continue to rest with the forest industry and the provincial governments. Financial assistance from the federal government may be expected under the terms of the Canada Forestry Act (1949). The operating procedures developed by Forest Protection Limited in Eastern Canada (*11, 12*) and by the British Columbia Loggers' Association on the west coast (*5*) will continue to serve as useful guides for effective cooperative action under Canadian conditions. In cases of conflict among natural resource interests in infested areas, a recently formed interdepartmental committee representing federal government agencies concerned with forest insects, forestry, fisheries, and wildlife problems has the responsibility of studying the situation *in toto*, and recommending appropriate action.

It is more difficult to foresee the scope of silvicultural control of forest insects in Canada. In several important forest insect problems the severity of infestations and damage is traceable, with varying degrees of certainty, to such stand characteristics as composition, age, area under uniform cover, and so on. This has encouraged entomologists to set forth the general concepts of silvicultural control (*1, 21, 22*), based on presumptive evidence from different stand types during or after destructive outbreaks. It has not been possible to make critical concurrent studies of population dynamics in unregulated susceptible stands and in others managed on silvicultural grounds for maximum resistance to insect damage; stands of the latter kind do not exist in Canada. Nor has the entomologist been concerned with other problems facing the forest manager, or with the criterion of economic feasibility (*12, 16*). Some of these problems are receiving careful attention in the Green River area of New Brunswick, where the results of research in forestry, forest entomology, and forest pathology are available to the operating company, which is not, however, under any obligation to accept uneconomic recommendations.

The large areas required for significant experiments in silvicultural control, and the long periods to effect the desired conditions and to test their efficacy during succeeding insect outbreaks, are deterrents to the present use of this method of reducing insect damage in Canada. Establishment of large forest experimental areas where commercial timber operations could be carried on under subsidy, possibly under the provisions of the Canada Forestry Act (1949), might be one method of encouraging wider experimentation in the use of silvicultural control.

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Answers to Some Criticisms of Aerial Spraying in Forest Management[1]

Robert L. Furniss

AERIAL SPRAYING is a comparatively new tool in forestry. For practical purposes, it came in with DDT during World War II. Now chemicals are being applied aerially to forest lands to control insects, diseases, and unwanted plants, and to stimulate tree growth. These and other uses of chemicals are a promising means of increasing the nation's commercial wood supply.

Aerial spraying, in common with many other innovations, has created problems. To a degree these problems are associated with the aerial application of chemicals for any forestry purpose. However, public anxiety has been particularly aroused by damage to fish and other forms of animal life during large-scale aerial spraying projects against insects.

About one million acres of forest land in the United States are sprayed annually to control insects. Against the spruce budworm alone, approximately 25 million acres in the United States and Canada have been sprayed since 1949.

From coast to coast and border to border, forest spraying is protecting forests, young and old, against destructive insects—spruce budworm, black-headed budworm, Douglas-fir tussock moth, pine butterfly, white pine weevil, gypsy moth, sawflies, and others. The list is long, and getting longer. Many kinds of insect-caused losses that formerly could not be prevented, no longer need be tolerated.

However, Utopia is not yet attained. Much criticism, ranging from valid to rabid, has been leveled at forest spraying. The authority of the government to spray private lands for the common good has been questioned in the courts, but so far upheld. The criticism goes on, gaining momentum and believers. The tide must be turned, if we are to retain spraying as a forestry tool.

All this public furor must have some basis in fact, so let's look at some of the responsible criticism. No need to consider the wild charges—that DDT is more of a threat to man than atomic fall-out, that it causes man to lose his virility, that it creates mutations producing human monstrosities, that it causes human ailments from cancer to heart failure. This is the irresponsible type of criticism that commonly obstructs scientific progress. Fortunately such charges become more and more fantastic until they discredit the accusers.

But much of the criticism is not irresponsible. It is made by people genuinely concerned about the effects of potent chemicals distributed widely over field, forest, and stream. Many of these people and the organizations they represent also sponsor adequate protection of our forest resources against pests. They do not oppose chemical control of pests, but they do want to insure that attendant losses of fish and wildlife are not unreasonable. Their opinions must be carefully weighed.

Some critics say that no research on possible harmful effects was done before forest spraying was begun. Many of these people are convinced that practically nothing is known about the effects of DDT upon man, let alone its effects upon other mammals, birds, and fish. They are concerned about possible hidden and delayed effects that will show up years later. Some national outdoor organizations have recommended that the Department of Agriculture stop all insect control programs in which toxic chemicals are broadcast, unless incontrovertible evidence becomes available that no serious damage to human or wildlife resources will result. If carried out, this would spell the end of forest spraying for a long time. The clear implication of this recommendation is that current control projects are based on inadequate knowledge.

The facts are that the Agricultural Research Service, state Agricultural Experiment Stations, colleges, industrial laboratories, and others have made exhaustive studies of the toxicity of DDT and other insecticides. Certainly none of the oldtime insecticides ever went through such thorough tests as have been made with DDT. Prior to forest spraying with this insecticide, the Fish and Wildlife Service and the then Bureau of Entomology and Plant Quarantine studied the effects of DDT spraying upon fish, fish food, and birds. Those studies led directly to the methods still being used.

I do not mean to say that we know everything we should about forest spraying with DDT. Far from it. My point is that we know enough, and methods are safe enough to warrant continued use. We cannot just close the books on forest spraying and turn the forests over to insects until there is no possible hazard from insecticides. All insecticides are toxic in some degree, both to insects and other animals. Our responsibility is to see that insecticides are applied so they do the insect control job with minimum hazard to other resources.

Some critics say that forest spraying is not effective. They are a minority and not very logical. On one hand they say we destroy everything, and on the other that we can't even kill the insect we're aiming at. This unfounded charge can easily be refuted by a great mass of data accumulated during the past 10 years or so. For in-

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[1]Adapted from a paper presented at the 49th Annual Meeting of Western Forestry and Conservation Association in San Francisco, Calif., December 11, 1958.

stance, from 95 to nearly 100 percent of the spruce budworm is killed by aerial spraying.

Some critics say that forest spraying upsets the balance of nature. They have blind faith that nature, if left alone, will cure everything. In a sense they are right, but we cannot tolerate great destruction by pests while waiting for nature to strike her balance. That may have been all right while the forest industry was growing up, but now that the wild forest is being tamed and put to domestic use, a better order has to be established. The dirt farmer had to do this; the tree farmer also will have to do it.

The forest owner or manager finds it particularly hard to accept the proposition that spraying isn't necessary because nature is doing all right without man's intervention. He looks at his own lands where likely as not insects are rampant. He reads the Timber Resource Review and learns that in a typical year insects kill 5 billion board feet of sawtimber, besides having an even greater impact on growing stock. This does not include the catastrophic outbreaks that periodically kill additional billions of feet of timber. These losses are nature's way.

By controlling forest pests, man can reduce this waste and thereby increase forest production. Aerial spraying is one of the tools through which this can be done. Rather than upsetting the so-called balance of nature, forest spraying is done to hold the line until natural forces—parasites, predators, disease, and climate—take over. It's an emergency measure that is not taken, and should not be taken, until nature is thoroughly upset.

Spraying against the spruce budworm in the Pacific Northwest has been directed against an outbreak nature permitted to cover millions of acres. Had our spraying caused an upset, we would expect a flareup following spraying. What happened was that the budworm was reduced to a very low level and remained low, despite a continuing outbreak on nearby unsprayed lands. Infestation on these lands, when sprayed, also became low. Admittedly, in some other parts of the country the budworm has built back more rapidly. In those places we need to know why.

Some critics say that spraying kills the parasites and predators that keep harmful insects in check. That is true to a degree. The insecticide that will kill one particular insect, and no others, has not yet been formulated. One problem is to protect the parasitic insects feeding inside the insect we wish to kill. Many of them die when their host insect is killed.

Again drawing upon experience with the spruce budworm, we have found that some kinds of parasites are hard hit by spraying, perhaps even harder than the budworm. Others fare better, depending upon where they are at time of spraying. We do not wipe out any of them, just as we do not kill every last budworm. In time, they all build back.

The best measure of the effects of chemicals upon beneficial insects is their abundance as compared with the abundance of their host, following spraying. For the parasites of the spruce budworm we have found that, percentagewise, there is no great upset. This is evidenced also by the fact that the budworm has not run rampant following spraying. Of course, efforts to find more selective insecticides and better ways to protect beneficial insects should be continued.

Some critics say that forest spraying builds up resistance in the insect being controlled, hence is self-defeating. This criticism comes from experience in controlling other kinds of insects—houseflies and mosquitoes, for example.

Resistance is developed only when many successive generations of an insect are exposed to a particular insecticide. In forest spraying, the general practice is to spray an area only once, or at most only a few times, and then suspend spraying for long periods. In the Northwest since 1949, nearly 5 million acres have been sprayed against the budworm and only about 2 percent of this acreage has been resprayed. There is no evidence of resistance to DDT. When the insecticide is applied properly, the budworm dies.

Hence we can say categorically that forest spraying, as currently practiced, presents little hazard that the insects will develop resistance.

Some critics say that forest spraying destroys fish and other wildlife. They point to known instances of killing of fish on budworm control projects in New Brunswick, British Columbia, Montana, and Oregon, and on gypsy moth projects in the northeastern United States. They tell of sterility induced in game birds. The impression is created that wholesale destruction has resulted from forest spraying and that even worse is yet to come.

What are the facts? Certainly fish have been killed, some directly by DDT; others indirectly through reduction of the aquatic insects that fish feed upon. New and important studies have been made in Canada, Montana, and Oregon by specialists on aquatic biology. Richard Graham[2] has reported on significant studies made by the Montana State Department of Fish and Game and other cooperators.

From these studies and practical experience, we are learning that the effects of spraying upon fish are erratic, that under some conditions more fish are killed than at first thought. However, killing of game fish is seldom, if ever, complete in any one stream. In many streams no evident effects have shown up where it counts most—the catch of sportsfish. In Oregon, many fine trout streams, among them such famous ones as the Mckenzie and Metolius, have been sprayed without any indication from fishermen that the fish catch had been reduced.

Even when fish kill does occur, it is well to keep in mind that the sprayed area involves only a fraction of the fishing waters in a state. Further, fish populations build back

[2] *Use of Aerial Spraying in Relation to Fish and Wildlife*, a paper presented at the 49th Annual Meeting of Western Forestry and Conservation Association in San Francisco, Calif., December 11, 1958.

much more rapidly than do trees. Finally, it should be recognized that uncontrolled insect epidemics often are followed by fire, which creates unfavorable fish habitats through siltation and loss of shade.

Although the charge of mass destruction has not been substantiated, aerial spraying obviously is harmful to fish under some conditions. We need to know just how harmful and under what conditions so that preventative measures can be taken. Foresters and fish biologists must work together, as has been done in Montana, to learn the facts.

Enough for what the critics say. What must we do to meet the valid criticisms? First, we must continue to make sure that spraying is necessary in each case, and that it is the best method to use. Second, we must take all possible precautions to avoid damage, yet obtain maximum benefits from spraying. Third, we must continue to seek better methods and less harmful chemicals. Fourth, we must take positive action to retain aerial spraying as a forestry tool. Let's look at these four "musts" more closely.

1. *Judging necessity of control.* We have three general types of control to choose from—forest management, biological, and chemical. Much can be done through salvage and various types of cutting to control outbreaks and make stands less susceptible to insects. This is a long-term method and is not effective against all insects. Biological control by parasites, predators, and diseases is most effective against introduced insects. It, too, is a long-term method. Chemical control is the one method suitable for combatting emergency outbreaks. It's the last resort, reluctantly taken.

Not all insects are equally destructive. Even with the most destructive insects, many outbreaks subside naturally without causing appreciable damage. We must be highly selective in deciding when spraying will be done, for there is not enough money to knock down every outbreak, even if we had control methods for all. Unlike the fire suppresion people, who control all fires, we must decide in every case whether or not to control. The decision is difficult and the responsibility heavy.

Having learned from surveys which insects are active, and taking into account what they are likely to do, we must assess the values at stake and thereby determine the benefits of control. Normally the cost of control should not exceed the financial benefit derived. When damage to fish or wildlife seems likely, the comparative value of the forest and wildlife resources must be considered.

These are the orderly steps taken in deciding upon control. The regional forest pest action councils provide a public forum for discussing and deciding upon the needs. Through their public airing of all the facts, the councils insure that the necessity for spraying is both real and urgent and that all possible precautions are taken in applying control. These councils deserve the full support of all practicing foresters.

2. *Taking precautions to avoid damage.* In aerial spraying, considerable can be done through known procedures to minimize spray deposit in streams and lakes. These methods, involving such things as block layouts, spraying patterns, and spray equipment, need not be discussed here, except to say that they are standard practice on most control projects and should be continued. It is highly desirable, too, that fish and game specialists work directly with entomologists and others in planning and carrying out aerial spraying projects, both to guard against excessive damage to wildlife and to evaluate any damage that may occur. A good start has been made toward such teamwork.

3. *Developing better control methods.* Much needs to be done to find means whereby fish can be protected still further without seriously reducing effectiveness of control. Public Law 85-582, enacted in August 1958, authorizing the Department of Interior to study the effects of insecticides, fungicides, and herbicides upon fish and wildlife for the purpose of determining the amounts and formulations of chemicals that can be used safely, will be very helpful. Research under this legislation, particularly with birds and mammals, is in progress. Additional studies like those in Montana are needed. Entomologists, fish and animal biologists, toxicologists working as teams are needed. Some of the things these teams and other research workers must do are:

(a) Assess accurately the damage done and the circumstances under which it occurs. (b) Develop more selective insecticides and better ways of formulating them so as to minimize harmful effects. (c) Develop better ways to apply the chemicals. (d) Investigate other possible means of control, such as growth hormones, induced sterility, and attractants. (e) Improve biological assessment and control procedures through basic studies of the insects themselves.

4. *Protecting the right to spray.* We who have the responsibility of growing and protecting forests could, through inattention, lose aerial spraying of forests as a management tool. This applies to weed control and the many other promising uses of aerial spraying, as well as insect control. To guard against this calamity, we need to adopt and carry out a 4-point program: (a) Make sure that control projects are sound. (b) Publicize the facts regarding control needs and control accomplishments. (c) Support the research that is needed to find the true facts and to develop better and less harmful methods of control. (d) Join the fight to retain forest spraying in our kit of management tools.

This is a big assignment, one worthy of being a major plank in the forestry platform of the Society of American Foresters.

Airplane Spraying in Forest Insect Control—Equipment and Techniques

J. S. Yuill and D. A. Isler

AERIAL APPLICATION of insecticides for controlling forest insects was first tried in Ohio in 1921, when lead arsenate dust was distributed from a JN6 biplane to control an infestation of catalpa sphinx moth. Considerable experimenting in aerial control was conducted during the next several years to develop methods for controlling outbreaks of insect defoliators in widespread forested areas, but none came into general use in the United States or Canada. The trouble was that insecticides in dust form did not adhere well to coniferous foliage and second, even with the most concentrated sprays, the volume required made aerial operations too expensive to be practical. Thus the situation remained pretty much unchanged—there was no way to combat these extensive outbreaks, some of which killed as much as 90 percent of the merchantable trees in the infested areas.

Practical Application Developed

The break-through for forest insect control by aerial application came shortly after World War II, when research showed that DDT sprays were effective at extremely low dosages in controlling many insect defoliators, thus bringing the method within the realm of practicability. Many problems had to be solved, however, before aerial spraying could be adopted as a general practice in forest insect control. Advantage was taken to the extent possible of developments made during World War II by the Armed Services in aerial spraying for mosquito control; also of fast-breaking developments in aerial spraying of agricultural crops. But many problems are peculiar to forest spraying alone. For example, in this work control costs must be kept as low as possible, because of the low per annum values at stake. In addition, greater spraying heights are required because of unevenness both in the terrain and in the forest canopy; and different flight patterns must be followed, especially in mountainous areas. These problems have required considerable research over the past several years.

FIG. 1.—Two airplanes spraying in paired formation.

As a result of this research, and through experience, forest spraying has developed into a specialized phase of aerial application of insecticides. Many problems are yet to be solved, but equipment and procedures are gradually becoming standardized. Control costs, which averaged around $3.00 per acre on some of the early projects, are now averaging less than $1.00 an acre on some of the larger projects.

Aircraft and Apparatus

Most of the aircraft used in forest spraying were designed for other purposes—primarily military. Immediately following World War II the Stearman biplane trainer was most commonly used. When equipped with a 450 hp engine, this airplane flies at 90 mph and can carry a 125 gallon spray load with adequate performance for the rough terrain and high altitude of western forests. It also is widely used in the East, where many of the forested areas are comparatively small in size. In recent years, however, there has been an increasing trend toward larger planes for many of the big operations, especially in the West, because they carry more insecticide, fly faster, and fewer are needed to do a job. Some of the larger planes which have been used are the trimotor Ford, Flying Fortress, C-47, Flying Boxcar, and the TBM torpedo bomber. Helicopters have been tried only on a limited scale. In most instances they cannot compete with fixed wing aircraft because of higher costs and lower pay load. Generally speaking, their maneuverability and their ability to fly "low and slow" makes them best suited for spraying small, high value plantations.

Of the many kinds of spray apparatus the boom and nozzle sprayer has gradually supplanted the other types and is now specified in most forest spraying contracts. Developed first for light biplanes it has since been modified for installation on larger planes, including the Flying Boxcar. Principal components of this sprayer are a tank or tanks mounted inside the aircraft; a pump; a tubular boom with atomizing nozzles attached to the airplane wing; and connecting plumbing with a shut-off valve. The popularity of this type of sprayer is due to its simplicity. It is fairly easy to build; the flow rate can be adjusted without changing the spray atomization simply by changing the number of spray nozzles; and atomization can be adjusted by varying the size of the nozzles, pointing them forward or backward, or changing the pump pressure. Many types of nozzles have been tried on

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this sprayer. Commercially made, hollow cone and flat spray nozzles have been the most satisfactory on light planes. Tests are still in progress to determine the nozzles which perform best on the larger planes.

Research has shown that for best spray distribution, the length of the nozzle boom should be not less than half wing span and not greater than full span. At the flying heights normally employed in forest spraying, and at the customary application rate of 1 gallon per acre, this equipment will lay down an effective swath about 4 to 5 times as wide as the wing span of the spray plane. The degree of spray atomization also has been shown to be an important factor in effectiveness of aerial spraying. Sprays of "medium"[1] atomization give the best results. Coarse sprays produce narrower swaths of streaky deposits, and extremely fine ones are not satisfactory because of spray loss resulting from drift and evaporation.

Insecticides

DDT has been virtually the only insecticide used in forest spraying to date. The usual formulation is an oil solution containing 1 pound of DDT, 1.2 quarts of auxiliary solvent and fuel oil to make 1 gallon. In the United States the usual application rate is 1 gallon per acre. In Canada much of the spraying for spruce budworm has been at the rate of ½ gallon per acre. On large control jobs carried out under the Forest Pest Act, finished DDT solution, transportation to the airfield, and storage and loading facilities are obtained from commercial sources on bid contracts.

In the few trials made with other chlorinated hydrocarbon insecticides they were found to be either less effective or more costly. Very little work has been done with the new organic phosphorous compounds. Most of these are highly toxic to humans and have been considered too much of a hazard to pilots and loaders. However, certain ones, such as malathion, do offer promise.

[1]Mass median diameter approximately 150 microns; i.e. half the volume of the spray in drops smaller than 150 microns and half in drops larger.

FIG. 2.—Dyed card with spray drops. Quantity of spray is estimated by comparison with "standard" cards carrying known amounts of deposit.

Problems of Spraying

One of the major problems in forest spraying is to maintain uniform spacing between flight lines. It is impossible to use flagmen to mark each pass as is done in crop spraying, except in young plantations. Sometimes it is feasible to put cloth panels or other markers in the tops of trees at the corners, or along the boundaries of units to be sprayed as a guide to the pilots.

On large control jobs in the West, markers are impractical. The blocks are too large; their boundaries are too irregular; and they often are inaccessible to ground crews. Furthermore, the rough terrain requires contour or down slope flight lines. Here the usual procedure is to lay out the blocks on aerial photos, using features of the terrain, such as ridges, peaks, changes in forest type, etc., as boundaries. Then the pilot makes a preliminary flight over the block in an observation plane to familiarize himself with the boundaries and the terrain, and to make a general plan of the direction he will fly over different parts of the block.

FIG. 3.—Larvae dead from polyhedrosis disease following spraying.

In actual spraying, he relies entirely on his own judgment, and on the help of landmarks for spacing the flight li. es. Some pilots are considerably more proficient than others in estimating the spacing, but even the best pilots often make rather large errors. Efforts have been made to overcome this on the large spruce budworm control operations in New Brunswick. Here, light planes (and later the larger TBM's) worked in pairs, with the first plane in the lead and the second to the side and slightly to the rear. By placing the more proficient pilot in the lead plane, his judgment on swath spacing served for both. The second pilot had the less difficult task of maintaining proper spacing between planes.

Other advantages to this system are (1) training experience for the pilot in the second plane and (2) providing a means for prompt notification to rescue crews in case of an accident. Some of the new electronic guidance systems are being tried for controlling swath spacing for the large multiengine spray planes, but present investigations have not progressed far enough to tell whether these devices will be practical.

Another pressing problem in forest spraying is how to increase the height of flight for greater safety. On the first extensive control jobs, 50 feet above the trees was the height specified for light planes, and 100 to 150 feet for larger planes. It was not possible to maintain these low heights at all times, but efforts were made to keep as close to them as possible. Through research and experience, spraying heights in the West have been gradually raised and most contracts now call for a 250 foot min-

imum and a 400 foot maximum, with provisions for greater height where the terrain requires. Recently some large scale tests have been made with multiengine planes from a height of 750 feet, but results so far are inconclusive.

The most critical problem in aerial spraying is weather. We do not know a great deal about its various effects, but we do know that air movement (wind and convection) is undoubtedly the most critical factor. A general crosswind, up to about 2 mph, seems to be helpful since it tends to smooth out irregularities in distribution across the spray swaths, and gives more uniform coverage through the tree crowns. With increased wind velocity, though, more and more of the falling spray is carried away from the target area; amounts getting down to the trees are less and less adequate for controlling the insects; and the part that does get down is not evenly deposited. In other words, the more wind, the less control over the distribution of the spray.

Convection currents usually develop a few hours after sunrise and tend to keep the spray from settling into the trees.

Rain also can be important. Not only can it seriously delay a control program, but if spray is applied too soon after a rain, a considerable amount may literally float off the wet foliage. Likewise, if rain falls too soon after the spraying, the deposit may be washed off.

The best time to spray is during the early morning, starting as soon as there is light enough to fly, but sometimes conditions also are satisfactory just before dark. Spraying should not be conducted when the wind velocity above the trees in the spray area exceeds 6 mph. It also is common practice to stop spraying when the temperature is greater than 68° F, because objectionable convection currents often occur at higher readings.

One of the best ways to evaluate air conditions is to watch the behavior of the spray itself from an observation plane. When the trail of spray behind the plane is seen to stay intact as it settles into the trees, and to move laterally at a slow rate, conditions are satisfactory. On the other hand, when the spray trail is rapidly chopped up, does not settle into the trees, or shows any strong horizontal drift, particularly up-slope, conditions are not satisfactory. Experienced observers in "chase planes" are being employed more and more on spray projects, especially where large planes are used. They add considerably to the effectiveness of operations because they not only can tell whether the spray is going down properly, but they also can make sure the pilots are spraying the assigned blocks and are doing the job in a workmanlike manner.

Measuring Results

Two important requirements in aerial spraying are to determine suitable methods for measuring deposit and for determining spray atomization. Precise methods are required in research; less refined, but faster ones in control operations. An adaptation of a dye tracer method developed by the military is being used successfully for measuring deposit in research. The method consists of dissolving a known quantity of dye in the spray and later measuring the amount of dye in the samples of spray deposit.

Various less exacting methods have been tested for measuring deposit on control jobs. So far, oil-sensitive cards have been the most satisfactory. These cards are made by dipping a special paper stock in an acetone solution of an oil soluble red dye. When exposed to atomized oil spray, each drop makes a circular spot on the dye coating. The quantity of spray on a card is then estimated by visually matching the card with "standard" cards carrying known amounts of deposit.

During the past few years, two methods have been developed for measuring spray atomization. One of these is called the proportionate area method. This is a precise procedure in which spray deposit samples are collected on dyed cards and the drop spots on the cards are measured and counted according to a predetermined sampling scheme, based on diameter class frequency. The degree of spray atomization is then calculated from these measurements.

The second method gives only a rough estimate but it is simple, rapid and adequate for field work. In this instance deposit samples are

Fig. 4.—Helicopter equipped with boom and nozzle sprayer. Carries approximately 50 gallons.

Fig. 5.—Four hundred fifty h.p. Stearman equipped with wind driven spray pump and boom beneath the wings. Carries up to 150 gallons of spray.

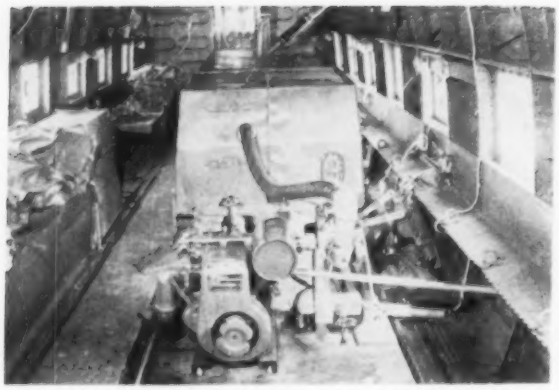

FIG. 6.—Interior of C-47 spray plane showing tanks and gasoline engine driven spray pump.

FIG. 7.—C-82, Flying Boxcar, with spray boom beneath the wings. Carries 2,000 gallons of spray.

collected on dyed cards as before, but only 5 to 10 of the largest drop spots are measured. The degree of atomization is then determined by applying a simple conversion factor.

What of the Future?

Aerial application for forest insect control has come a long way since the first experimental dusting in Ohio almost 40 years ago—a long way even since the first trials with DDT in 1944. In this country over 10 million acres have been sprayed under the Forest Pest Act to control outbreaks of spruce budworm and other defoliators; an equal amount has been treated under the Gypsy Moth Control program; and even more extensive forest areas have been sprayed in Canada to combat spruce budworm. Only 15 years ago such outbreaks would have had to run their courses killing most of the infested trees.

What about the future of aerial application? Eventually advances in silvicultural methods, tree breeding, parasites and other natural controls, we hope, will make our forests more resistant to insect damage. Even with the best natural control, however, it seems reasonably certain that there will be upswings in insect populations and aerial application will be needed to keep them in check, sometimes on widespread areas. The aim, of course, is that direct control will become more and more a supplement to natural control. To this end investigations are underway to find cheaper and more selective insecticides and more efficient techniques for putting them on. Studies also are being made of the possibility of applying the insect disease viruses and other biological agents from aircraft.

In the West the principal use of airplane spraying will continue to be for the protection of the extensive areas of mature forests from devastating defoliator outbreaks. Since most of this work will be done with large planes over mountainous terrain, there is an urgent need for further research to develop techniques for increasing the height of flight.

Aerial application in the East and the South will be on a more limited scale but it is expected to increase considerably. Because of the less extensive forest areas most of the work will be done with light planes and helicopters. One of the principal problems which seems to be developing is the need for aerial application to control insects in plantations and other high value areas. Not much is known about the best materials or techniques to use for many of the insects which are important here, especially for terminal feeders (tip moths, weevils, etc) and for seed and cone insects.

Airplane spraying is not and probably never will be a panacea for all of our forest insect troubles. Many of our most important insect pests, such as the bark beetles, still must be controlled by other means. Nevertheless, the method has permitted, for the first time, a means for successfully controlling outbreaks of insect defoliators. Continuing research undoubtedly will provide still more effective materials and methods for use in aerial application to control these and other insects. The possibilities for accomplishing this are by no means exhausted.

What About Biological Control?

Philip B. Dowden

THE QUESTION whether biotic factors can be used to control forest insect pests comes up persistently whenever we are faced with economic losses, and properly so. Some spectacular successes have been achieved with the biological-control method. Furthermore, even a superficial study of an insect usually brings out the fact that it is attacked by a variety of parasites, predators, and diseases.

It is perfectly logical, therefore, to wonder whether these agents can not be put to work for us. Unfortunately biological control, like other methods of control, has its limitations. But this does not alter the fact that it is distinctly worth while to examine the record, consider the possibilities, and look for possible applications in this extremely promising field.

An exceptional opportunity to study the record and to appreciate the interest in biological control has been provided by the recent publication of the *Proceedings of the Tenth International Congress of Entomology* held in Montreal in August 1956. No less than 483 pages are devoted to this subject, second only to "agricultural entomology" with 491 pages.

Biological control has had its greatest use against introduced pests and its greatest success on islands or ecologically isolated areas. Its greatest economic value has been against pests of tropical or subtropical plants such as citrus, coconuts, and sugar cane. The most easily controlled pests are sedentary, gregarious species, notably scale insects and mealybugs.

Predators Imported

Comparatively few foreign forest insect pests have become established in North America; and in all cases where at all practical, parasites, predators, and diseases have been collected in the native habitat for release in America. As pointed out in an earlier article (*6*), there are nine imported pests that can be considered tree killers. We are now actively engaged in importing the predators of one of them, the balsam woolly aphid. More about this later. Two others, the European spruce sawfly and the European pine sawfly, are now controlled by biotic factors. Four pests—the gypsy moth, European pine shoot moth, larch case bearer, and larch sawfly—are partially controlled. The beech scale has no predators of consequence in Europe, so no work along this line has been initiated. The origin of the red pine scale is unknown.

The balsam woolly aphid deserves special attention because we are still importing its parasites and predators. It probably became established in Nova Scotia about 1900, and from there spread gradually through the Maritimes and northern New England. Recently it has been found causing serious tree mortality over a wide area in the Pacific Northwest and locally on and near the Pisgah National Forest in North Carolina.

FIG. 1.—Predators at work: these adult Calosoma beetles are killing gypsy moth larvae. This predator (*Calosoma sycophanta*) was introduced from Europe. Both adults and larvae attack the gypsy moth in this country, and they are important in the biological control of the pest.

Several species of predators were introduced into Canada from Europe between 1933 and 1941, but only one *Neoleucopis obscura* (Hal.), was successfully established. The work was revived in 1950. Since then three more predators have become established. Neoleucopis does not control the aphid, and it is too early to determine how effective the new species will be, so the work is being continued. The Canadians have provided several colonies of these predators for release in the Pacific Northwest. They also had investigators searching for predators of the aphid in Pakistan and Australia in 1958. The U. S. Forest Service sent the writer to Japan on a similar assignment that same year.

Using Biotic Factors

The biological-control method as used against introduced pests is now well known and accepted. The possibilities of using biotic factors against native pests, and as a way of obtaining direct control, much as we use an insecticide, are scarcer and certainly less obvious. This is not because biotic factors rarely affect native pests. Quite the contrary; most native pests have an abundant supply of parasites and predators. It is because the biotic factors are periodically ineffective or the increase of the pest is due principally to environmental conditions. It is risky to generalize, but a couple of examples may clarify this point.

But before taking up specific examples we should perhaps point out that the chances of successfully manipulating biotic factors are far better against some groups of insects than against others. The leaf-feeding species—Lepidoptera,

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Hymenoptera, and Coleoptera—offer the best opportunities, because most trees can stand considerable defoliation without serious injury, and biotic factors thus have an opportunity to increase in numbers and effectiveness before serious tree mortality occurs.

Much the same conclusion can be made regarding sucking insects, although there are very few native sucking insects that are serious forest pests. The imported *Adelges piceae*, of course, kills trees quickly. The bark beetles and borers offer the poorest chance of success. Even when populations are low, if these pests successfully attack a tree, they kill it or destroy the timber. Furthermore, populations may build up very rapidly in windthrown or overmature timber, and these excess numbers of pests may kill healthy trees that are capable of resisting the attacks of normal-sized populations.

Budworm An Example

The spruce budworm, a native defoliator, is one of our worst tree killers. The uninformed would certainly be justified in concluding that natural control factors fail completely to hold it in check. This is not quite the truth. It has an abundant supply of parasites and predators. At least 61 species have been listed and no doubt others will be discovered (*7, 8*). Most of these are rare or seldom encountered, but parasitization by several runs high at times. In fact there is no doubt that biotic factors hold the pest in check locally for long periods.

The budworm has been present in outbreak proportions in Canada since 1935. During this period, heavy tree mortality has occurred in Ontario, Quebec, and New Brunswick. Serious defoliation occurred suddenly in the Adirondacks of New York in 1946 and at several points in northern Maine between 1948 and 1958. Nevertheless, the Adirondack infestation and several local Maine infestations subsided before tree mortality occurred. These outbreaks were obviously checked by natural factors. In 1958 it was feared that natural factors could no longer be relied upon in Maine, and 302,000 acres were sprayed with DDT.

The events in the Adirondacks and Maine seem to show, however, that biotic factors operate successfully from an economic standpoint as long as the outbreak remains localized, but are incapable of holding the insect in check when extensive areas become involved. Under such conditions, when an outbreak increases to epidemic proportions there is little possibility of increasing the effectiveness of biotic factors by increasing the number of individuals operating against the pest. In all budworm outbreaks that have been studied intensively, all of the important parasites and predators have been present in considerable numbers even when parasitization was low.

To illustrate this point; there probably are 100,000 budworm larvae per acre even when an infestation is so light that feeding is barely noticeable. If only 1 percent of the larvae are parasitized by a particular parasite, 1,000 adult parasites should emerge per acre. It is thus rather obvious that it would be a tremendous job to increase the number of individual parasites of any one species over an extensive forested area, and also that it is extremely doubtful if the added number would increase parasitization materially. This is true because the individuals already present probably never reach their full reproductive capacity and added individuals would only compete for the limited number of hosts suitable for that particular species.

It would appear necessary, therefore, to find some new or heretofore unavailable biotic factor if we are to use one successfully in natural stands against a native defoliator like the budworm.

The Engelmann spruce beetle is a typical bark beetle that occurs occasionally in epidemic proportions. Such a situation occurred in Colorado in 1941 and again in 1953, when devastating outbreaks followed severe windthrows of Engelmann spruce in 1939 and 1950. The pest has numerous natural enemies. Parasites and predators kill about 50 percent of the brood; and woodpeckers are extremely important, killing practically the entire brood in some areas. Yet these natural factors are unable to check a heavy outbreak if an abundant supply of windthrown timber is available. Clearly, then, under such conditions, there is almost no possibility of increasing the known biotic factors or of manipulating them so that they will control an outbreak.

If these two examples seem pessimistic they are meant to be realistic and are cited to emphasize the fact that usually important biotic factors are operating against our native pests even when these pests are able to increase to epidemic proportions. So in order to use biotic factors to advantage against these pests, it will be necessary to find new factors or to use those already present in an unusual or different manner. In some cases this may be feasible, and several possibilities are being tested.

Exciting Possibility—Pathogens

Perhaps the most exciting possibility being tested against forest insects is the greater use of insect pathogens. Entomologists have long sought practical methods for using insect diseases either for direct control, much as an insecticide is used, or for reducing insect populations permanently. The method has, of course, many advantages. The most important perhaps is that insect pathogens are harmless to all except their own particular host or to hosts that are very closely related.

Success has been achieved in a few cases, a notable one being the use of the milky disease of the Japanese beetle. In 1950 excellent control of the European pine sawfly was obtained when a virus disease of this pest was suspended in water and sprayed on infested trees (*2*). Since that time similar sprays have been applied successfully from the ground and air, not only against this pest but also against the Virginia pine sawfly, the Great Basin tent caterpillar,

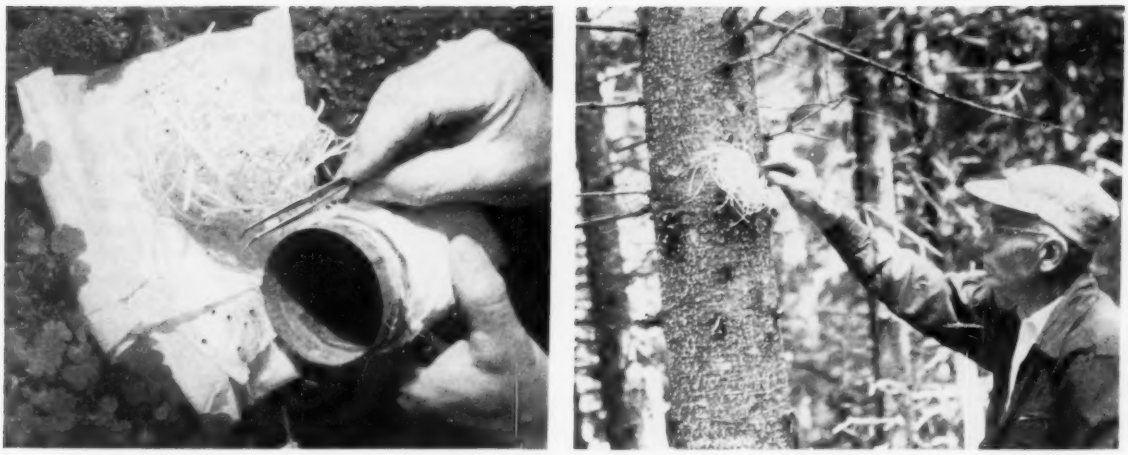

Fig. 2.—European predators of the balsam woolly aphid being put to work in southern Vermont. *Left*, the predatory beetles (*Laricobius ericksonii*) are packed in slightly moistened excelsior and kept cool. *Right*, the beetles are released on heavily infested trees.

the wattle bag worm, and the alfalfa caterpillar.

A very important factor in this work is the pathogenicity of the virus. The European pine sawfly has a highly pathogenic virus with an LD 50 of 100—500 polyhedra per larva per os (*3*). Complete control of the pest was effected when 5 billion polyhedra in 2 gallons of water were applied per acre by airplane (*9*). Thompson *et al.*[1] have noted that sprays containing 30 billion polyhedra per acre of the range tent caterpillar virus were much more effective than sprays containing 10 billion.

Since the polyhedra must be ingested to infect the host, it is apparent that it may be very difficult to spray enough polyhedra on the foliage to cause an epizootic if the virus has a very low pathogenicity. This is particularly true if the spray is applied from the air. This may explain in large part why preliminary experiments using gypsy moth virus in airplane sprays have been unsuccessful inasmuch as the LD 50 of gypsy moth virus is about 5.5 million polyhedra per gypsy moth larva (*1*). In spite of this, the method looks promising indeed, and even if the use of viruses is strictly limited, it should prove extremely valuable against certain pests.

This is particularly true where extensive areas are involved and the application of the virus may initiate epizootics that spread naturally the following year. Work against the Great Basin tent caterpillar has demonstrated that although complete control was seldom effected the year of application, it was generally achieved the second year following treatment; also that induced polyhedrosis outbreaks usually spread in much the same way as natural ones (*5*).[1]

Some Other Developments

Many other developments in the use of diseases as biological control agents might be mentioned. Superior strains of certain pathogens, such as *Bacillus thuringensis* Berliner, have been discovered and are being used. Timing has been found more important than realized. For instance, early instars of the army worm are very susceptible to viruses against which later instars are much more resistant (*12*). In some cases a synergistic association of two viruses may result in increased virulence of the pathogens (*12*). This sort of information may very well lead to the practical use of certain pathogens hitherto considered of little value.

The possibility of establishing biotic factors affecting native insects in areas where they do not occur is one that has obvious possibilities. Strangely enough, attempts to establish certain western spruce budworm parasites in the Northeast seem to have failed. Good results followed the colonization of an elm beetle pupal parasite into California from the East, and a rather striking example of success has been reported from Japan (*14*). A parasite of an introduced scale insect was discovered locally there that proved to be highly effective when distributed rather generally.

The use of related species in biological control work also has considerable possibility. In some cases spectacular success has followed such an approach. Perhaps the most notable was the control of the Levuana moth in Fiji by a larvaevorid fly found parasitizing a related host in Malay and Java. Recently Townes (*13*) has called attention to the fact that it may be more fruitful to search for parasites and predators in an area where allied species are plentiful than in an insect's native habitat if it has few natural enemies there. In this connection, it is of more than passing interest that *Pineus borneri* (Ann.) appears to have been controlled in New Zealand by *Neolecucopis obscura* (Hal.); the same species that was successfully established against *Adelges piceae* in Canada in 1933 (*11*).

The possibility of using biotic factors for the direct control of injurious insects in plantations should not be overlooked. As al-

[1]Thompson, C. G., C. L. Massey and H. E. Ostmark, unpublished manuscript.

FIG. 3.—Parasite at work: this parasite (*Dahlbominus fuscipennis*) is laying eggs inside a sawfly cocoon. About 30 parasites will develop at the expense of the sawfly.

ready pointed out, there is not much hope of increasing the effectiveness of parasites and predators under natural conditions, but plantations are usually restricted areas presenting quite a different problem. Great success has been achieved in the control of introduced scale insects infesting citrus trees in California through the mass rearing and liberation of parasites and predators. There would seem to be no reason why equally good results could not be achieved in forest plantations, provided effective parasitic or predacious species were available.

Control Through Sterilization

One more possibility, control through the use of sexually sterile males, should be mentioned. This principle was used with spectacular success in eradicating the screw worm fly from the island of Curacao. Males were sterilized by irradiation in the pupal stage. When a female mates with a sterile male, she lays only infertile eggs and, since males mate repeatedly and females only once, the release of large numbers of sterile males gradually eliminated the natural population.

An attempt is now being made to repeat this success on a much larger scale in Florida. Intensive research is also being conducted against fruit flies in Hawaii, where the method is believed to show promise both for eradication and for community or area fly control (*4*).

One naturally wonders whether some forest insects might be controlled in this manner. There are a number of limiting factors. Means of mass-rearing the insect must be available, adequate dispersion must be obtained, sterilization should not affect the males' mating habits, and females should mate only once. If these limitations are kept in mind, the possibility of using the method should certainly be given consideration. Tests using the white-pine weevil have been conducted (*10*), but they were negative, because females mate more than once, and they may be fertilized even after mating with sterilized males. Other possibilities will certainly present themselves.

This rather brief survey of biological-control work on forest insects and some rather obvious possibilities for further investigations cannot hope to answer all of the questions implied in "What about biological control?" It may answer a few. The most important factor in regard to biological-control work is that so many people ask that question.

The possibilities in forest insect work seem good. More research is needed, and the general demand for greater forest protection plus general dissatisfaction with the widespread use of the newly invented organic, synthetic insecticides in forest areas should assure us that the biological-control method will be given a fair trial.

General approval and sympathetic interest do not take the place of active research, however; and if the biological-control method is to be effectively used, more projects involving biological control must be sponsored in forest insect research programs.

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The Gypsy Moth Control Program

W. V. O'Dell

THE GYPSY MOTH was brought to the United States from Europe for experimental studies in 1869. By accident the insect escaped at Medford, Massachusetts and established itself in that community. Before the turn of the century public funds had been expended to control the Massachusetts infestation; nevertheless by 1906 it had spread into areas of adjoining states. Since that time there has been continuous control and suppression work by the state and federal governments.

Gypsy moth populations have shown a consistent pattern of increase and decline. Severe outbreaks have occurred periodically and greatest spread has occurred during such epidemics. By 1956 the moth was generally spread over approximately 40 million acres involving most of New England, a large area in eastern New York, and adjacent territory in both New Jersey and Pennsylvania.

For more than a half century the gypsy moth has been the subject of numerous studies and special surveys. Almost always such activities have resulted in the conclusion that the moth has markedly affected the aesthetic, timber, and recreational values in areas where long established; that it is a serious threat to the hardwood forests of the eastern United States, and that cooperative activities to control and prevent spread of the insect should be strengthened.

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History of Spread

For many years gypsy moth infestation occurred only east of the Berkshires and Green Mountains in New England. However, by 1922 the leading western edge of infestation had reached the New York border. Through joint action of the federal government and the states involved, a barrier zone program was then inaugurated. The purpose was to halt further westward spread through intensified efforts to locate and then eradicate any infestations found within the barrier zone area. Along the eastern front of this zone somewhat of a natural barrier was formed by the Berkshires and Green Mountains. Within this continuous mountain range, the occurrence of a northern hardwood type of forest, high elevations, and late spring frosts were factors believed to favor chances for successful barrier zone operations. As long as infestations within this zone remained small in number and size, they were effectively controlled with the ground-rig spray equipment then available.

Objectives of the barrier zone program were successfully accomplished for nearly two decades. By repeated survey and control operations within the zone, infestations were found and exterminated while still in an incipient stage and before there was opportunity for a major build-up or break-through. In the early forties, however, this situation ended abruptly. In the first few years following the hurricane of September 1938, light infestation was found generally spread throughout the northern half of the barrier zone involving portions of western Vermont and Massachusetts and extending into the Champlain and upper Hudson Valley sections of eastern New York. The full extent of this westward spread was not ascertained until after several successive surveys had been conducted with sex-attractant traps.

By the late forties, centers of heavy infestation had developed at scattered points in the recently expanded periphery of infestation. Build-up and spread helped to join these islands into a pattern of continuous, general infestation, culminating in the epidemic which occurred from 1952 through 1954. During this outbreak nearly 1½ million acres of woodlands were defoliated in 1953 alone. Follow-

FIG. 1.—Ground cover characteristics of stands in Northeast that are resistant to the gypsy moth. Note Aralia, New York fern, white ash, and Lycopodium.

Photo courtesy Harvard Forest.

FIG. 2.—Mixed oak stand susceptible to defoliation by gypsy moth. Note its open character and the absence of understory and ground cover.

Photo courtesy Harvard Forest.

ing the outbreak additional extensive spread of infestation was found, and on a scale comparable to that which had occurred 15 years earlier. With this latest enlargement, the area of gypsy moth infestation now involved approximately 40 million acres, extending through all of eastern New York and into bordering sections of New Jersey and Pennsylvania.

Advent of DDT and Aircraft in Gypsy Moth Control

When DDT became available for civilian use following World War II it proved to be a particularly effective insecticide for the gypsy moth. At about the same time, the application of insecticides in concentrated form by aircraft became a practical undertaking. Early tests demonstrated that eradication of infestation could be achieved by aerial application of one pound of DDT in one gallon of spray per acre. Exhaustive research showed that at this dosage DDT was safe for use in all areas when a few simple precautions were observed in application methods.

During the next several years many centers of heavy infestation within the overall area were suppressed or brought under control by aerial spraying with DDT. Infestation in some outlying areas was eradicated, notably one of 300,000 acres in the anthracite region of Pennsylvania. Aerial spraying for control in eastern Massachusetts resulted in a total absence of defoliation on Cape Cod for the first time in many years. These spray activities amply demonstrated the effectiveness of DDT against the gypsy moth. They were not of sufficient scope, however, to stem the tide of increasing moth abundance during those few years before the explosive outbreak which reached an epidemic peak in 1953.

Threat of Continuing Spread

The occurrence of established infestations west of the former barrier zone posed a threat of continuing spread to hardwood forests throughout the eastern and southern United States. The magnitude of this threat had been determined by a special survey in 1952 in connection with an overall appraisal of the gypsy moth program. This survey had shown the susceptibility of the threatened stands to attack by the gypsy moth and the related potentials for stand damage.

In conducting the survey, research data reported in Harvard Forest Bulletin No. 22 titled "Forest Site Conditions and the Gypsy Moth" were used as guide lines. Forest site susceptibility as discussed by the authors, Bess, Spurr and Littlefield (1947), appears to be determined by presence of favored food plants in combination with dry site and poor stand condition. These association factors were given major consideration in conduct of the survey. Excluding infested states of the Northeast, more than 100 million acres of hardwood forests were found to be susceptible to gypsy moth attack in the areas studied. Significantly, the degree of susceptibility in these areas was calculated to be considerably greater than anything observed within the generally infested region except on a very local scale.

Review of Program Operations and Objectives

When the full extent of spread was determined following the 1952-54 outbreak, the implications involved were cause for alarm in areas lying in the path of possible further spread. In the light of information provided by the earlier susceptibility survey, the potentials for additional large-scale spread were readily apparent. The size of the infested area was not only greatly expanded but infestation had advanced to the threshold of a vast territory in which susceptible forest site conditions were commonly present.

At this stage the problem received attention on a national scale by various organizations interested in the protection and preservation of our hardwood forest resources. The concern of these groups was reflected when representatives from 15 states met with federal officials in March 1956 to review the existing situation and to consider the gypsy moth program with respect to future operations and objectives. Recognition was given to successes that had been attained by aerial application of DDT for control and eradication purposes, as well as to the potentials involved in timber losses and annual control expenditures if the moth were permitted to spread throughout its natural range in the eastern United States. After consideration of these matters, a decision was reached that an attempt should be made to eradicate the gypsy moth from the United States. The initial objective was stated to be elimination of infestation west of the Berkshires and Green Mountains, and restoration of the natural barrier afforded by the forest type, climate, and physiography of that region. Implementing this decision, funds were provided for initiating eradication work in outlying areas in 1956. The Congress then agreed to support a continuing eradication effort, subject to availability of federal and state funds on a cost sharing basis.

Progress in Eradication

When the decision was made to eradicate the gypsy moth there was much history on the safe use of DDT. Some of the earliest research with this material was conducted on the gypsy moth program by the U. S. Department of Agriculture and the Fish and Wildlife Service of the U. S. Department of Interior. Results of that research have served as a basis for operating procedures by state and federal agencies in the control of gypsy moth on several million infested acres. In all of this work, no harmful side affects of a lasting nature were demonstrated following application of the recommended one pound per acre dosage of DDT. The sensitivity of fish and their aquatic food organisms was recognized and special precautions were observed to avoid direct application of DDT sprays to fish habitats.

With such a background of research and practical field experience, it was natural when eradication was proposed that DDT should be considered as the made-to-order tool with which the job could be effectively and economically accom-

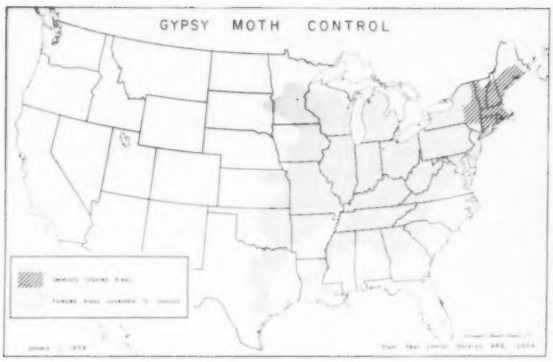

Fig. 3.—Regions infested by and vulnerable to the gypsy moth.

Fig. 4.—Massachusetts hillside in background defoliated by the gypsy moth.

Photo: USDA-ARS M137.

Table 1.—Acreage Sprayed—State-Federal Gypsy Moth Eradication Program by State and Year

State	1954	1955	1956	1957	1958	Total
New Jersey	.....	.....	152,098	189,427	0	341,525
New York	.....	.....	356,028	2,578,954	63	2,935,045
Pennsylvania	.....	.....	89,140	237,550	493,200	819,890
Michigan	86,400	35,970	81,388	19,840	0	223,598
Total	86,400	35,970	678,654	3,025,771	493,263	4,320,058

plished. Actually, the eradication effort was started in 1954 when an outlying infestation in central Michigan was initially treated for this purpose. The overall eradication effort was instituted in 1956 and has progressed to date as shown in Table 1.

Prior to initiation of the eradication effort, the program had encountered no particular problem in relation to the residue left by a DDT spray. Up to that time farmers themselves were applying DDT to their stables as well as directly on dairy cattle and other animals. However, the 1954 Miller Amendment to the Federal Food, Drug and Cosmetic Act of 1938 now made it necessary to give serious consideration to this subject. No tolerance had been established for a residue of DDT in milk as had been done in the case of fruits, vegetables, and meat. This meant that henceforth milk moving in interstate commerce would be subject to seizure and exclusion from the market if found to contain any amount of DDT residue.

In association with program operations, the Department of Entomology in the College of Agriculture at Cornell University conducted residue studies in 1957. These studies demonstrated that residues in milk cannot be avoided when DDT spray is applied to gypsy moth host plants located adjacent to forage crops and in pastures. Such findings resulted in an interruption to the eradication program planned for 1958; especially in New York State where spray work had previously progressed to the edge of a more or less continuous dairy type of countryside.

During the 1958 spray season, new insecticides were tested for effectiveness against the gypsy moth in both laboratory and field operations. Of the many tested, four were considered sufficiently promising to warrant further screening. Initial cattle feeding tests with one material have shown no residue in milk to date. Higher level feeding tests are being continued at Cornell with the same material. Should these tests show favorable results the material would be a top candidate for use in those areas where DDT cannot be used because of the residue problem.

A resumption of large-scale eradication efforts in 1959 depends largely on results of current studies. Continuing research is needed in the quest for better tools and methods for use in the years ahead. Cooperative teamwork among the agencies and institutions concerned with program operations should find the answers to current problems and open the way for successful and timely achievement of overall objectives.

Bark Beetle Control

Noel D. Wygant

BARK BEETLES killed 4½-billion board feet of sawtimber in 1952, accounting for 90 percent of the insect-caused mortality and 63 percent of the growth impact (8). This is believed to be a representative year for bark beetle-caused losses. The western pine beetle killed 18.6 billion board feet from 1921 to 1937 in Oregon and California; the mountain pine beetle, 15 billion board feet from 1911 to 1935 in Idaho and Montana; and the Engelmann spruce beetle, 5 billion board feet from 1940 to 1951 in Colorado. Many other outbreaks of near-catastrophic proportions developed in the West since 1900 by these and other bark beetles. These stark facts command a critical review of where we stand today with bark beetle control and research and what research is needed to develop more effective prevention and control methods.

Status of Knowledge About Bark Beetle Control

Bark beetles vary widely in their habits and effect upon the forest. A great deal is known about a few species but our knowledge about most of them is still fragmentary. In no case is the knowledge complete enough to understand and evaluate all the interactions of the bark beetle populations with the host tree and stand, weather and climate, parasites, predators, and diseases.

Space does not permit a thorough review of all information about bark beetles. In general and with a few examples, the status of our knowledge about the ecological factors influencing bark beetle abundance, causes of outbreaks and their decline, and control methods is as follows:

Life cycles.—The length of the life cycle varies widely with the species and climate. Species such as the southern pine and western pine beetles may have as many as five generations per year in their southern range. The Engelmann spruce beetle may have as few as one in three years at high elevations in Colorado. The rapidly maturing species frequently develop outbreaks in a short time. Most bark beetles overwinter in the phloem or outer bark in various stages. Some species of Ips adults emerge in the fall and overwinter in the litter. The Engelmann spruce beetle and some species of Ips may hibernate beneath the bark at the base of the tree.

Food requirements.—Most of the tree-killing bark beetles are host specific or at most feed upon the species in one genus. Ips engraver beetles rear large broods only in slash, windthrown trees, fire-killed, and drought-weakened trees. After building up large populations, they may kill large numbers of immature trees. Dendroctonus beetles prefer mature and overmature trees. The western and southwestern pine beetles prefer overmature trees in poor health and develop major outbreaks only when the stand as a whole is weakened from drought, overmaturity, or overstocking. The mountain pine, Black Hills, and Engelmann spruce beetles will develop outbreaks in stands of normal vigor. Between outbreaks they are present in the forest in relatively small numbers. Bark beetle outbreaks reach their greatest magnitude in pure and extensive stands of a susceptible age class. The black turpentine beetles breed in stumps and bases of southern pines and in recent years have become a major problem in the South.

Sources of outbreaks.—The high biotic potential alone is not responsible for outbreaks. The rapidity of the development of an outbreak is more closely associated with the number of beetles breeding in single trees, windfall, slash and cull logs; the length of the life cycle; and the biological vigor of the source population.

Dispersion and attraction.—Bark beetles fly only short distances when a local susceptible host supply is available. After the supply is exhausted, they may fly greater distances; for example, the Engelmann spruce beetle is known to move in large numbers and establish new outbreaks up to 30

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FIG. 1.—Groups of ponderosa pine infested with the Black Hills beetle indicate an incipient outbreak.

miles distant. Very little is known about the motivating factors of the flight and the nature of the attraction of bark beetles to their favored food supply.

Effects of weather and climate.—Temperature directly affects the rate of development. Abnormally or unseasonally low temperatures occasionally decimate a population, but in general bark beetles are well adapted to the temperature in their range. The cold hardiness of the different species varies rather widely, which probably delimits the range of the less cold-hardy species such as the southern pine and western pine beetles. Windstorms of high velocity that cause extensive blowdown frequently lead to outbreaks. Notable examples are the recent outbreaks of the Douglas-fir beetle in western Oregon that resulted in the loss of 3 billion board feet and the Engelmann spruce beetle outbreak in Colorado that resulted in a loss of 5 billion board feet. Lightning-struck trees are highly susceptible to bark-beetle attack. Fire-scorched trees are also a favored breeding source for some beetles. Prolonged droughts that weaken entire stands frequently induce outbreaks of the southern pine, western pine, and southwestern pine beetles, and Ips and Scolytus.

Biological control factors.—Except in a few instances, the roles of biological agents as controlling factors are not fully understood. Many species of parasitic and predaceous Diptera and Hymenoptera and predaceous Coleoptera have been collected from bark beetle trees. Rapidly developing wood borers that follow bark beetle attack deprive bark beetles of food. The recent work of Massey (*4*) shows that parasitic nematodes reduce the egg-laying capacity of the beetles. Mites are abundant in the galleries, and on the insects. Some of the mites, many of them undescribed, are predaceous. The most notable example of a biological agent controlling bark beetle outbreaks is that of the northern three-toed, hairy, and downy woodpeckers controlling the Engelmann spruce beetle. Woodpeckers are sometimes active in outbreaks of other bark beetles during the winter and during the mature larval and pupal stages.

Direct control methods.—The early methods were to fall and burn the infested trees or to peel the bark and expose the developing insects. Gibson (*1*) developed a formulation of orthodichlorobenzene in fuel oil for control of the mountain pine beetle. His formulation was later used with good success against many other species of bark beetles. In recent years, water emulsions of ethylene dibromide have come into wide use in the West (*5*). Formulations of benzene hexachloride have been highly successful against several bark beetles in the South. The use of these insecticides is expensive and somewhat limited because of the high cost of locating the infested trees, transportation of the insecticide, and applying the chemical. Trees with infestations above 30 feet must be felled, which adds to the cost.

Logging infested trees and burning the slabs is widely used where a road system exists or can be constructed in time, and the mill capacity is adequate to process the infested logs. Infestations in which the trees are widely scattered may be uneconomic for logging control. Also, the necessity for shifting logging operations to outbreak areas often disrupts an orderly harvest.

Trap trees have been tested as a control method for several species of Dendroctonus but found to be effective for the Engelmann spruce beetle only. This beetle has a strong preference for green, felled trees. Quantities of beetles, up to 10 times or more, will crowd into a felled tree rather than attack a standing tree (*6*).

Cultural control methods.—Successful silvicultural control methods have been developed for the western pine beetle through sanitation-salvage cutting of infested and high-risk trees (*3, 7*). The victory came from many years of detailed research. Similar methods are applicable to control of bark beetles with similar habits such as the southwestern pine beetle. But for most bark beetles, little or no progress has been made in developing silvicultural control methods. Until a much greater amount of research is accomplished, recommendations for reducing damage through silvicultural management must come by deduction.

Needed Research

Prerequisite to an understanding of the causes of the rise and fall of bark beetle outbreaks and the development of more effective control measures is more detailed information about bark beetle biology, physiology, and natural mortality factors. To accomplish the needed research, each of these broad subjects should be divided into individual studies and carried out by specialists. Some of the work should be carried out in the field and some of it in well-equipped and controlled laboratories. The findings from each of the intensive and narrow lines of research provide no direct basis for development of control measures. But when combined with other new information and applied, the end objectives should be reached. Some specific areas of needed research are as follows:

Life histories.—The life histories of each of the major pest species need to be intensively studied in several areas to learn the geographical variations, host differences, and periods in their development most vulnerable to direct control attack. Such studies should be carried out in endemic as well as epidemic areas to learn of possible differences in biological vigor between the two populations and what factors in the environment control the change. Life history studies along with environmental measurements near the boundaries of the pest species' distribution may prove to be especially helpful in understanding environmental requirements. For example, environmental factors restrict the southern limits of the Black Hills beetle to northern Arizona and northern New Mexico. Yet ponderosa pine extends much farther south in pure and large areas.

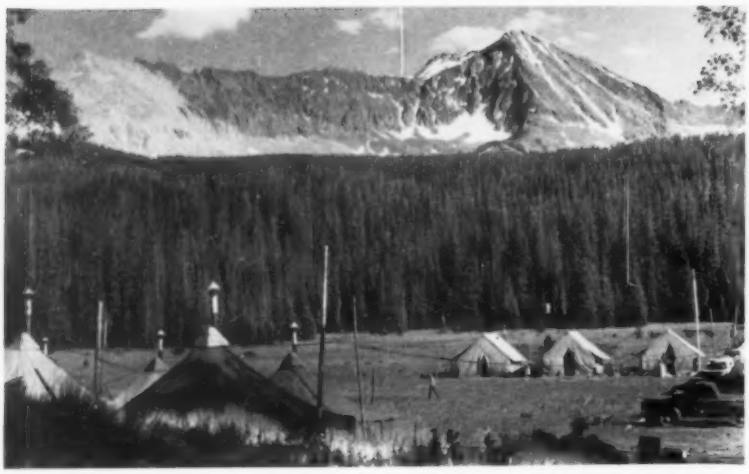

FIG. 2.—Engelmann spruce beetle control camp on the Uncompahgre National Forest, Colorado, August 1955. More than 50 percent of the trees in the background contain heavy broods that would emerge and infest the nearest green trees. Dolores Peak in the background.

Taxonomy.—Without sound taxonomy, accurate identification is impossible. Without accurate identification, biological and ecological data cannot be compared, and the use of literature is greatly impaired. Studies are needed of populations comprising species and lesser categories and their degree of relationship. The work by Hay (*2*) shows that the Black Hills beetle and mountain pine beetle are probably one species. Other species may need to be combined. Also, it is important to be able to know and identify the biological differences that may exist in strains within each species.

Biology and physiology.—One of the greatest needs is the development of laboratory rearing methods and facilities to produce a dependable supply of vigorous bark beetles for testing insecticides and host resistance, and for physiological and biological studies. Particularly needed is a synthetic food to standardize the mass rearing procedure. In developing the synthetic food much would be learned about the nutritional requirements of bark beetles, attraction, and host resistance. That food requirements are critical is evident by their host specificity. This may be due to toxic substances within the nonhost species or to nutritional deficiencies. Also within a host species may be found individual trees that are resistant to the pest bark beetle.

Closely associated with the study of food requirements is the study of attraction. That bark beetles often have strong preference for windfelled trees, slash, and weakened trees has already been mentioned. That the beetles are able to find this host material is proof of the existence of an attraction. Other than the fact that bark beetles working in a tree or log attract additional beetles, we know little of the nature of the attractant, how it is transmitted, and how and by what organ it is received by the beetle and how the beetle is guided to the host.

FIG. 3.—Chemical treatment of spruce infested with the Engelmann spruce beetle.

Also of possible significance is the fact that bark beetles are attracted to and individually find the host—they do not swarm and find their host by chance—even though their successful attack of a living tree is dependent upon a mass attack. Another indicator of their acuity of senses is the manner in which they uniformly distribute their points of entrance in a tree to avoid competition of their progeny for food.

Many kinds of microorganisms are associated with bark beetles both in their digestive tract and in the galleries. These include yeasts, fungi, protozoa, and nematodes. Their role, if any, in the biology and control of the bark beetle should be determined. Universally associated with bark beetles are one or more kinds of staining fungi. The mycelium of these fungi permeate the sapwood, stop conduction, and hasten the death of the tree. The spores are carried on and in the bodies of bark beetles. The importance of this association and the possible symbiotic role should be more intensively investigated.

General observations of bark beetle infestations show that mortality during the flight period is often high. Intensive study should be made of the anatomy and physiology associated with the function of flight, dispersion, and effects of physical factors and biological agents upon the success of beetles reaching their new host tree.

Biological control factors.—Life histories and habits of all the common insect parasites and predators, mites, and parasitic nematodes should be studied and the immature forms of each described. Information about this group of factors is especially needed to improve the precision of biological evaluations of infestations. While no cases have been observed in which a representative from this group of factors was solely responsible for cessation of outbreaks, further study may show that in combination they may be responsible for initiating the decline of outbreaks and for holding bark beetle populations at low endemic levels for long periods.

While the chances of successfully finding and introducing additional predaceous or parasitic forms to supplement the native ones are small, such possibilities should be explored.

Insects in general are subject to attack by representatives of practically all groups of microorganisms including rickettsia, fungi, protozoa, viruses, and bacteria. Several have been studied to some extent for potential use as microbial control agents. A comprehensive survey should be made of bark beetle populations to discover, describe, and test such pathogens that may indicate a potential for microbial control.

Physical factors.—Some of the needed studies on the effect of physical factors have already been mentioned in conjunction with the biological studies. Especially needed is information about the effects of weather during the flight period and effects of weather and climate on distribution and population fluctuations.

Breeding for host resistance.—Opportunities for developing bark beetle resistant varieties will be greatly improved after the basic information is obtained on the mechanisms of host resistance and bark beetle attraction. In the meantime, resistance tests of superior tree varieties developed by geneticists should be made. Perhaps caging methods can be developed for testing resistance on small trees to avoid the long wait for the new varieties to reach the bark beetle susceptible age and size.

The opportunity for selecting resistant trees from wild stock should not be overlooked. There are indications that individual trees within an outbreak area show inherited resistance. For example, an occasional ponderosa pine is able to pitch out a heavy attack of the Black Hills beetle. A comparison of the rate of growth and visual evidence of vigor of such trees with the killed trees indicates little difference. In any event, a study of the anatomy and physiology of such trees would make a good starting point for host resistance research.

Silvicultural control.—The methods developed for control of the western pine beetle should be tested against the southwestern pine beetle. The value of breaking up extensive stands age-wise and species-wise should be observed and tested against other species.

Chemical control—The need for a more economical chemical control method warrants increased research to develop an insecticide that is effective when applied by aircraft, Recent advances with systemic insecticides against agricultural insect pests indicates good prospects for achievement. Also, there is a need for effective residual type insecticides that will give long protection of green trees and one that will kill beetles emerging from infested trees. The direction of research for development of an effective bait should depend upon the findings of the studies on attraction.

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The Douglas-Fir Bark Beetle Epidemic on The Millicoma Forest: Methods Used For Control and Salvage

Arthur V. Smyth

THE MILLICOMA FOREST is an industrial tree farm of the Weyerhaeuser Timber Company located in the Coast Range of southwestern Oregon, principally in the Coos River drainage. The area is characterized by steep and broken terrain with elevations ranging from 600 to 3,000 feet. The climate is typical of the Oregon Coast range—heavy winter rains and summer droughts.

Most of the forest consists of a dense, even-aged stand of almost pure Douglas-fir 180 years old. Understory western hemlock and western redcedar make up the remainder.

At present the forest supports a modern sawmill and a particle board plant located in North Bend, Oregon, on Coos Bay. The mill began operation early in 1951. Logging began in the summer of 1950. Previous to this the property was almost entirely an undeveloped wilderness.

Concurrently with the first development of this forest property it was hit by an epidemic of the Douglas-fir bark beetle (*Dendroctonous pseudotsugae* Hopk.). The losses from the windthrow, which preceded the insect attack, and from the beetle itself were extremely heavy. It is estimated that nearly a billion feet of the original stand was killed by windthrow and beetles. The purpose of this paper is to report briefly what was done in attempting to control the beetle population and how the immense job of salvage was handled.

History of the Epidemic

The tremendous build-up in the bark beetle population was triggered by severe wind and snow storms during the winter of 1949-50. During this winter several hundred million feet of timber was either blown down or broken off by snow. This material was scattered throughout the forest and provided an ideal breeding ground for the bark beetles. During the spring of 1951 the beetles emerged from this windthrow and began attacking the surrounding green timber. By the late summer and fall of 1951 the forest was dotted with hundreds of patches of dead and dying Douglas-fir.

FIG. 1.—Ground view of groups of Douglas-fir killed by beetles.

On December 4, 1951 the region was hit by a hurricane-force storm with winds up to 115 miles per hour. Again the forest suffered tremendous losses from windthrow. With the beetle already at epidemic levels, this new windthrow boosted the beetle population to an even higher level. An important factor contributing to the heavy losses from windthrow was the high incidence of the root rot *Poria weirii* in many areas of the forest. By the spring of 1952 the mortality from the bark beetle was evident everywhere throughout the forest.

Detailed estimates indicated that 365 MM board feet of blowdown occurred in 1949-50 and 1951-52. This resulted in an additional 548 MM board feet of standing timber being killed by beetles during 1951 through 1954. With several hundred million feet of dead trees scattered throughout a forest property barely tapped by any roads, the salvage and control job seemed staggering.

Effect of Epidemic on Logging Plans

The problem confronting the foresters and loggers was two-fold: first, to control the epidemic by silvicultural means and second, to salvage the maximum amount of dead timber. Access was the key to the success of both programs; therefore in order to forestall additional build-up of the beetle population as well as to salvage as much dead timber as possible, it was imperative that roads be built as fast as practicable. The management authorized a "crash" program of road construction. During the summer of 1952 the construction department was placed on a double-shift basis. Tractors were outfitted with lights and by working in the hours before dawn and into the evening, sixteen hours of road construction were crowded into each working day. Previous to this time the mill had operated on a one-shift basis. It too was put on a two-shift basis at this time.

During 1951 and 1952 sixty miles of logging roads and spurs were pushed into the forest. Almost all of this construction was heavy, expensive work. From 25-30 miles of road have been built each year since.

The problem would not, of course, be solved by merely building roads. The roads had to be channeled into the areas where they would do the most good. The areas of heavy beetle kill had to be mapped and located to facilitate the logging plans. This was done by intensive aerial sketch mapping. The Company forestry airplane was used to grid the entire forest with a skilled observer

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FIG. 2.—Windthrow trees such as these created favorable breeding conditions for the bark beetles. Large numbers of beetles emerged from down trees to attack adjacent green trees.

FIG. 3.—Weyerhaeuser foresters examine beetle galleries on fallen Douglas-fir as part of research program to determine extent of beetle infestation.

plotting the groups of beetle-kill on topographic map sheets.

Later, some 60,000 acres of the forest were photographed with aerial echtachrome at a scale of 1:7,920. This large-scale, color photography proved invaluable in laying out high-lead, clearcut settings so as to encompass the highest percentage of beetle-killed timber. The beetle-kill occurred in scattered groups ranging from a few trees to many hundreds. Tractor logging was impossible in the rough and broken terrain characteristic of most of the area, making selective logging of only the dead timber impractical for the most part.

Through the united effort and planning of the entire logging, engineering, and forestry staffs the proportion of dead timber in the total log production was kept relatively high. During the entire epidemic it was the bark beetle which dictated the logging plans. As the forestry staff received the survey information as to the location and severity of the insect attack it was passed on to the logging department. The logging engineer and "bull buck" worked closely with the foresters throughout the epidemic. In fact, by the time the epidemic had run its course the Douglas-fir bark beetle was a familiar word to every logger on the operation.

Wherever the terrain permitted, tractors were used in conjunction with mobile loaders to clean up beetle kill and windthrow adjacent to roads. During 1958 a salvage team consisting of two D-7 tractors and a mobile shovel loader worked continuously on salvage. In the areas opened up with roads this mobile equipment was indispensable.

Silvicultural Control

While the forestry staff of the tree farm was concerned chiefly with the problems involved in removing the infested timber and with survey work to follow the trends of the epidemic, company, federal, and state entomologists, and pathologists were engaged in research on the life history of the beetle and on the rate of deterioration of beetle-killed timber.

Some of the research findings were put to immediate use in control work. For example, it was found that felled and bucked timber within a clearcut setting seldom produced a brood of beetles. Although the logs would rapidly fill up with beetles, new broods were not successfully produced in this material chiefly because the logs would dry out in the sun. In effect, logs on clearcut settings felled in the spring or summer would act as trap logs.

FIG. 4.—A 31 inch Douglas-fir codominant 4 years after being killed by bettles. The rapid decay has caused the sapwood to be completely destroyed for pulp and sawlogs. The heart wood is still suitable for pulpwood.

It was also found that logs cut for road rights-of-way during certain seasons were prolific breeders of bark beetles. Because the right-of-way logs lay in long, narrow strips throughout the forest, shaded from the direct sun, they became ideal host material. With the greatly accelerated road construction program almost 30 million feet of right-of-way timber were felled each year. Unless care was taken it was entirely possible that the road building program could in itself help maintain a high beetle population.

It was found that, generally speaking, right-of-way timber felled during the period of October to May was most likely to produce a new brood of beetles. Logging plans were therefore rearranged to remove these logs from the woods prior to late spring. Timber felled from May to October was generally dried out to such an extent by the following spring that it was not favored host material for the emerging beetles and thus these logs could be left in the woods for longer periods without danger of their contributing to the insect buildup.

Blowdown timber was in the same category as right-of-way timber in that it provided ideal host

FIG. 5.—Rapid extensions of logging roads into heavily infested areas enables Weyerhaeuser loggers to salvage timber before it is lost to decay.

material. Consequently every effort was made to take out all fall and winter blowdown by the following spring. For example, right-of-way timber falling, or blowdown occurring, in January of 1954 was removed before May of 1955 wherever possible.

So that it might be known what volume of dead material was being removed from the woods a marking system was devised for beetle killed and windthrown trees. The cutting crew was instructed to mark each beetle killed tree as it was felled and each windthrow bucked. The woods scalers then entered this volume on the scale sheets. By means of this system an actual log scale tally of all dead trees removed was available.

Rate of Deterioration

Investigators found, in studying the rate of deterioration, that the amount of rot was in direct proportion to the severity of the beetle attack in any particular tree or portion of tree. Also, it was evident that beetle-killed timber rotted at a much faster rate than windthrown timber. The sapwood portion of a bettle-killed tree was completely lost within a period of from one to three years. On an average tree this meant that 25 percent of the volume was lost within three years.

In addition to the loss from rot, the fact that the sapwood deteriorated so rapidly directly increased the breakage in falling. The loss from breakage, particularly in the older beetle kill, has been high.

The salvage program is now in its eighth year and most of the 1951 beetle kill not yet salvaged is almost completely lost.

By 1954 the beetle epidemic had run its course. Since then the population has been at a low level. During 1958 some areas of the forest again showed a slight build-up in beetle activity. It is highly significant, however, that there was no additional loss from bark beetle activity in the area that had been developed with a network of roads and where blowdown and right-of-way had been promptly cleaned up.

Summary and Conclusions

The following statements summarize the experience gained in the attempts at control of this explosion of a forest insect population and the subsequent salvage in its wake.

1. Large, unbroken areas of pure, even-aged stands are particularly vulnerable to insect attack. Knowing this, all such areas should be tapped with a network of logging and access roads to the greatest extent practicable. Roads are the key to forest management of any such area. This is textbook knowledge of course, but in the light of what occurred on the Millicoma Forest during the years 1951-1954 it cannot be overemphasized.

2. Systematic survey methods, either ground or aerial or both, should be so organized that any insect build-up can be promptly detected and located.

3. Prompt sanitation cutting and salvage of dead and dying trees, blowdown, and right-of-way logs will help prevent the build-up of bark beetle populations. Silvicultural control is the only practical means we presently have for the control of the Douglas-fir bark beetle.

4. The rate of deterioration in beetle-killed timber of the type found on the Millicoma Forest is rapid. In general, ten years is about the maximum time available for salvage.

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Control of Insects Through Silvicultural Practices

Samuel A. Graham

THE SPECTACULAR and successful control of some forest pests by the use of modern insecticides has caused the general public and even many foresters to think of forest insect control in terms of chemicals alone. As a result, the possibilities of controlling insects through wise management has been obscured. This is a mistake, because in many instances forests can be protected more effectively and more economically through the application of silvicultural treatments. It is the purpose of this paper to suggest briefly some of these opportunities.

The control of insects through silvicultural practices is usually preventive, in contrast to direct control through insecticidal treatments usually designed to cure a sick condition. But occasionally silvicultural operations can be applied to check an outbreak after it is under way. For example, the jack pine budworm can be checked in some stands by removing a few highly susceptible trees. When this can be done the cure is more permanent than is the temporary reduction of the pest numbers through the use of poisons; materials which cut down pest populations but do not change the ecological conditions that in the first place made the outbreak possible. In most instances, however, direct control of an outbreak through silviculture is impracticable after an outbreak has started.

The potential effectiveness of preventive control through intelligent management is directly proportional to the intensity of management. In an unregulated forest we may expect periodic outbreaks of insects to build up soon after a stage of forest development is reached that is favorable for the pests. These favorable conditions for insects may result from man's activities, logging for example; or they may result from the action of natural phenomena, wind, fires, or natural succession toward more and more tolerant species.

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The Origin of Outbreaks

The control of forest insects through silviculture rests upon an understanding of the causes of outbreaks. They are the result of a combination of circumstances and conditions that are conducive to the rapid increase of a pest. The potentially noxious species are always present in small numbers wherever the trees on which they feed are growing. Therefore, in every forest there is always the seed for outbreaks. The excessive rate of multiplication necessary to produce an outbreak is usually prevented through the action of parasites, predators, competitors, food limitations, or unfavorable weather.

Although it may be possible to create forest conditions through silviculture that will favor some parasites or predators, thereby helping to check the increase of a pest, the diversification of food trees affords more promising possibilities for silvicultural control.

Diversification

For example, when sugar maple, yellow birch, eastern hemlock, northern white-cedar, basswood, and elms are growing together in the northern hardwood type, severe insect outbreaks are virtually unknown. It is believed that the risks encountered by pests in their search for food in a mixed stand accounts, in part, for reduction of their rate of increase. Obviously silvicultural practices should be designed to maintain these safe conditions.

In contrast, if any one species of the northern hardwood forest forms a pure stand it becomes highly susceptible to outbreaks. For instance, pure stands of hemlock are certain to be attacked and severely injured by the hemlock looper; the severity of the resultant damage being directly proportional to the relative amount of hemlock in the stand. Pure stands of hemlock have been killed completely in a single season by total defoliation; witness the destruction of mature hemlock stands in Wisconsin and Michigan some 30 years ago, and the severe losses caused by the looper in the forests of the Northwest.

Similarly, an extensive forest of pure maple favors outbreaks of other insects, especially defoliators, leading to decadence of the trees and subsequent losses through both direct mortality and later attack by other insects and diseases that are ordinarily secondary. By "secondary" we mean pests that are unable to attack and complete development in a vigorous living tree. Both the primary and secondary species capable of causing injury to pure maple stands are too numerous to mention; webworms, leaf rollers, striped maple worm, and borers of several kinds.

Generally speaking, diversification of forest lands leads to lower risks than those to be expected on extensive lands occupied by a single species in a single age class. The desired diversification can be attained either by mixing species or age classes, since each species and age class is susceptible to different groups of noxious insects. In the Lake States during the Civilian Conservation Corps days mile after mile was planted to red pine and other large areas were converted to pure pine through so-called timber stand improvement. Today we are suffering from the results of these practices that brought into existence extensive pure and even-aged contiguous stands, and we are paying a heavy price in insect infestations for this error in judgment. Similar errors may be made again in our efforts to simplify the problems of forest regulations by adopting single species management, un-

der conditions where multiple species forests can be grown.

The established biological principle that environmental complexity leads to stability, whereas complexity leads to instability, applies in a conspicuous manner to the protection of forests against insects by diversification.

Although diversification is an important consideration in plans to prevent insect outbreaks, it is by no means the only silvicultural approach. Fitting species to site, thinning too dense stands, maintaining a protective overstory in some instances, preparing the site for planting, providing for dense reproduction, removal of high risk trees or stands, and numerous other practices will lead to the prevention of insect outbreaks. These possibilities will be illustrated by examples in the following paragraphs.

Fitting the Trees to the Site

Growing trees on suitable sites not only assures satisfactory survival and growth, but also affords protection against pests. Sometimes the thrifty trees growing on sites suited to their needs are actually less subject to attack by certain insects, such as barkbeetles and other phloem eaters. In the majority of cases, however, damage is lessened, not because the trees on good sites are inherently resistant to attack but because they develop rapidly and remain in a susceptible state for a fewer number of seasons.

For example, damage by the Saratoga spittle bug, the pine eucosma, the Nantucket pine moth and many other plantation insects declines sharply with the closing of the stand. Because young trees growing on poor sites are characterized by slow growth and often by poor stocking as well, such stands are subjected to many years of injury, whereas those on suitable sites outgrow the susceptible state within a few years, often promptly enough to prevent pest populations from reaching a high level.

There is, at present, an increasing appreciation of the advantages to be derived in pest control by fitting the trees to the site, and more will be heard on this subject when results of work now under way can be released for publication. But there is another angle that has received less attention; that is the negative aspect. By permitting trees to grow on sites to which they are unsuited, insect pests may be encouraged in increase to outbreak proportions. Then the adjacent stands on better sites may be injured by the overflow from poorer sites. The conclusion is, therefore, that trees should not be permitted to grow on sites too poor to permit their development to merchantable size.

Preventing Stagnation

On lands of relatively low site quality, but still good enough to grow merchantable trees, the forest after closure may tend to stagnate. Then damage by spittle bugs, aphids, scale insects, and leaf hoppers may appear. Under such circumstances, thinning is in order. Two specific examples will illustrate how thinning over-dense stands can limit damage by insects.

A striking instance of this occurred in Stinchfield Woods, a University of Michigan property near Ann Arbor. There, a 17-year-old plantation of Scotch pine had become heavily infested by the pine spittlebug and an associated fungus. The trees appeared to be dying, and almost certainly would have if left alone. A heavy thinning was made, thus reducing loss of soil moisture through transpiration. The effect was to improve conditions for the residual trees. Their health promptly improved and the spittle bugs returned to endemic numbers.

Sometimes nature uses insects to perform a needed silvicultural treatment. For example, from the University of Michigan aspen study it was found that the success of sucker reproduction depends upon establishment of a very dense initial stand of sprouts. After five years or so this dense reproduction usually stagnates. Then insects, especially sucking insects that feed on foliage, attack and kill part of the stand thus releasing the residual trees. These trees then have available a more adequate supply of soil water, are able to grow without excessive competition, and recover their good health. Stagnation such as this may occur several times during the development of an aspen stand, each time natural thinning by insects or fungi will occur. However, if justifiable financially, thinning with the axe or saw would result in a better final crop of wood.

A Light Protective Overstory

Sometimes outbreaks of certain insects on young stands may be prevented by maintaining a light protective overstory. For example, protection from the white pine weevil may thus be attained. The majority of our best stands of white pine in primitive forests grew up with aspen or white birch. That white pine grows reasonably well under a light overstory and ultimately will grow up through the canopy without weevil injury is a well-known fact. Therefore, species especially susceptible to injury by the weevil, such as pines or Norway spruce should be released from a light overstory with caution. Failure to recognize the hazards involved in operations of this sort has led foresters to conduct many undesirable release projects in the name of timber stand improvement. Severe damage by the white pine weevil followed which offset any advantage that might have been obtained by increased growth rate.

Site Preparation

Site preparation prior to planting may be necessary in order to prevent outbreaks of some insects. For instance, the Saratoga spittle bug lives on sweetfern, briars, and a few other plants during the immature stages. They injure pines during the adult stage only. Elimination of the food plants of the nymphal insects prior to planting will bring about complete control of the pest, one of the most injurious on pine plantations in the Lake States. Herbicides may be used to kill these food-plants and provide a means whereby site preparation may be accomplished economically in places where it seems advisable

to plant pines on lands occupied by sweetfern.

Maintaining High Density

The importance of maintaining high density in young stands of aspen has already been mentioned. This is because sparse stands are subject to the attack of a number of boring insects; two saperdas, several members of the genus agrilus, the willow shoot sawfly, and a number of other injurious pests. Dense stands, on the other hand, are injured lightly or not at all, prior to the period of stagnation previously mentioned. Therefore, the establishment of dense stands following logging should be sought. This objective can almost invariably be accomplished by clearcutting of aspens. This will stimulate the maximum production of suckers. Also, dense planting of white pine, which encourages early closure, will reduce injury by the white pine weevil. The trees growing close together are stimulated to straight growth and discouraged from forking, even though some of them may be injured by the weevil.

Removal of High-risk Trees

Removal of high risk trees is one highly rewarding silvicultural practice by which the danger of damage by insects can be ameliorated. Especially true in mature and overmature stands the possibility was first recognized by western forest entomologists studying ponderosa pine stands subject to barkbeetle damage. Since then, trees most likely to succumb to insect attack are being recognized in other forest types; for instance, forests containing hemlock, balsam fir, and, to a lesser degree, oaks. Even though the removal of all trees or stands that are susceptible to attack may not be immediately practicable, their recognition will nevertheless permit planning a cutting sequence that will start with the highly susceptible trees or stands. With each cutting the areas under management become safer.

Still other illustrations showing how silviculture can be used to control forest insects could be mentioned. But enough has been said to show clearly that the control of insects by silvicultural means has passed beyond the theoretical stage.

It is also clear that such control requires advance planning. It requires that a forest manager be trained to recognize the potentially dangerous insects that live in his locality and to understand their preferences. He must be able to recognize trees and stands that have attained a state susceptible to attack and injury by these insects. He must be able to arrange his cutting compartments in order of hazard, so that he can plan for their logging in order of susceptibility or, if an outbreak should arise, for their prompt salvage. He should also set up a system of annual examination of critical areas so that the need for salvage may be anticipated. And he must provide an adequate system of permanent access and haul roads so that needed operations can be conducted regardless of their location. Where these requirements have been met, the control of insects through silviculture can be realized.

Oregon Conference Looks to Future

Nearly 1,000 persons attended a Forestry Centennial Conference at Oregon State College, Corvallis, February 20-21. Held in connection with Oregon's centennial year, the conference stressed future developments in forestry and wood utilization.

Northwest, national, and Canadian forestry leaders forecast that Oregon's next 100 years in forestry will bring better and faster-growing trees, bred from selected and even "registered" parents, and with special seed orchards providing superior seed. Lumber and plywood products will be vastly improved by 2000. Slivery rough edges and unsightly knot defects will be gone. Various polishing and other treatments will beautify the products. A new approach to harvesting methods is foreseen; wood engineering developments will be spectacular; utilization of the "entire" tree-wood, bark, foliage, and chemical extractives—will become a reality; and dreamed of and undreamed of developments will revolutionize forestry operations in the next century.

The predictions of better forests and better forest products are not without their qualifications, however, the speakers emphasized. New problems are ahead also—particularly problems of population that will require doubling the annual timber growth by 2000 to meet the needs of 100,000,000 more people in the country. Recreation space needs are multiplying also and watershed management must look to "greater yields of useable water." Keys to advances were cited as forest genetics, research, imaginative minds, and education.

Systemics in the Control of Forest Insects

J. A. Rudinsky

THE RECENT DISCOVERY that various organic phosphorous and fluorine compounds with insecticidal properties are absorbed and translocated in a plant opened a very promising new field in plant protection. In fact, Reynolds (*5*) remarks that the development of systemic insecticides represents a turning point in plant protection comparable to the use of DDT. Considerable research has been done in the last dozen years on the inner therapy of agricultural plants, which is reviewed by Giang (*2*), Spindler (*6*), Bennett (*1*), and others. Research in systemics to protect forest trees from destructive insects, however, has not yet progressed so extensively.

Bennett (*1*) defined a systemic insecticide as a substance that is readily absorbed and translocated to other parts of the growing plant, thus rendering it insecticidal. The two types of systemics in use are distinguished according to their decomposition within the plant: (1) endolytic compounds, such as systox and dimefox, which in their original form act as insecticides until decomposed by the plant; and (2) endometatoxic insecticides, such as schradan, which are partially or completely metabolized by the plant into other toxicants.

When sprayed or dusted by common insecticides the plant serves only as a place of deposit; when systemics are used, it becomes an active participant in the subsequent processes of absorption, translocation, and detoxification which govern the ultimate effectiveness of the material. The basic research on the behavior of various systemic insecticides within a plant is therefore important to forest researchers, even though it was not done on forest trees. A comprehensive review of such work is presented by Spindler (*6*) and Bennett (*1*).

Most of the research with systemics against forest insects took place during the last seven years, and naturally many of the principles are not sufficiently known for present use on a large scale under forest conditions. In nurseries, young reproduction, and plantations, however, the use of systox and metasystox against sucking insects seems to be well established, particularly in Europe (*9*).

Systemic insecticides for use against forest insects are being screened at the Central States Forest Experiment Station (*12*). Both the toxicity of the various test compounds to trees and their effect on the insects are studied.

Methods of Application

Several compounds have been used against forest insects; of these systox (demeton), metasystox, and schradan were most intensively tested. Various methods of application were used, but only four appear promising.

Band method.—This method consists of wrapping a flannel or cotton band, saturated with systemic material and covered by a plastic strip, around the tree trunk. The material is absorbed by the bark and is initially translocated by the sieve tubes of the phloem more intensively upward than downward (*11*). Later it diffuses into the xylem, whence it moves more rapidly into the crown region. The band method is easy to use, no heavy equipment is required, and being local it does not harm beneficial insects.

Vité (*7*) reviews the use of the band method against forest insects. On larches both systox and metasystox were effective against thrips (*Taeniothrips laricivorus* Krat.) and young mining larvae of *Coleophora laricella* Hbn. Metasystox also was successful against *Adelges nüsslini* C.B. on young firs. On the other hand, metasystox was not effective against various species of bark beetles on spruce. Systox used on spruce neither prevented the formation of galls by adelgids nor killed the larvae within the galls. Also, schradan and systox applied by the band method to girdled pines did not affect the brood of the mountain pine beetle at 15 and more feet above the application point (*4*).

Injection method. — Systemic solutions are injected into the transpiration stream of the xylem directly through a hole bored into the trunk or by a leaf-shaped hollow knife driven into the sapwood. The transport of the material is then effected by the transpiration stream, and its distribution into the crown region depends, apart from environmental factors, on the water-conducting system of the tree. Among conifers the most complete distribution is in the tree species with spiral ascent of sap, while in the species with sectorial ascent the distribution is restricted to only a sector (*8*) (Fig. 1).

In young and rapidly growing parts, particularly terminals, the materials accumulate faster than in slow-growing parts. Limited lateral diffusion from the xylem into the phloem occurs, but the concentration in the phloem increases only slowly.

Because of the fast and intensive distribution over the larch crown, this method is considered superior to the band method in controlling thrips and the larch casebearer (*7*). Demeton, dimetox, and thimet introduced through a hole bored in the trees proved successful and fast in controlling larvae of the balsam gall midge on balsam fir, but dimetox had also a phytotoxic effect. Larvae of the red-headed pine sawfly on red pines were controlled with similar success (*3*).

It appears that both injection

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and band methods of application will have use on ornamentals, in parks, etc.; and, as suggested in Europe, they can be economical in mixed stands on trees of superior value (*7*).

Root application.—Systemic insecticides can be applied to the soil and absorbed by the roots. Recent research suggests that the most important factor is the contact between the roots and the insecticide. Greatest absorption is from solution, less from sand, and least from soil (*1*). There may be selective absorption or rejection of various insecticides by the roots. Translocation to the transpiration surface takes place in the xylem with some lateral diffusion into the phloem, as was mentioned in discussing the injection method (except that the distribution into the crown region is fairly uniform and does not depend on the system of water conduction as in the injection method).

Soil application of systemic insecticides (schradan, CR409, Hanane) has been successful in control of the mealybug, vector of swollen-shoot virus of cacao, mealybugs on coffee trees, and aphids on cotton, which schradan controlled for 53 days (*6*). Only a few experiments with this method have been performed on forest trees. Wollerman *et al.* (*13*) applied schradan and demeton at several concentrations with water or sand to the soil around black locust to control *Euchenopa binotata* (Say) with some result. Dilutions of schradan and demeton applied around lodgepole pine did not prevent attack by ips.

The advantages of soil application appear to be uniform and rapid translocation of the absorbed material by the xylem, less danger of toxic effects on beneficial insects, and longer effectiveness, as the systemics, being stored in soil, are available for a longer time. Because of insufficient intake of the systemic material especially by deep-rooting trees, however, this method is limited mostly to nursery use.

Foliage spraying.—When a systemic insecticide is applied to the foliage of trees, a number of processes, such as volatilization, absorption, translocation, and detoxification, take place simultaneously or consecutively. Absorbed material, or its metabolite, is translocated in the phloem, usually at a slower rate than material transported in the xylem.

Compared to standard insecticide spraying, this method is more promising than the others against forest pests; it has also been tried more extensively. Systox and metasystox, in 0.05 percent concentration, were successfully used against sucking insects, leaf-mining larvae of moths, and certain beetle larvae (*9*).

As suggested by the successful control of aphids on agricultural plants, the forest species of aphids (Aphididae) can also be easily controlled by systemics. However, these insects are seldom important in the forests. The well-known balsam woolly aphid, *Adelges piceae* (Ratz.), and its relatives, on the other hand, are highly destructive, and they are difficult to reach by contact insecticides because of their protective woolly cover. Spraying with systox and metasystox in 0.05 percent concentration (1.7 to 4 ounces of actual material per acre, according to size of firs) gave good control on reproduction and in nurseries (*9*). The material must be applied in

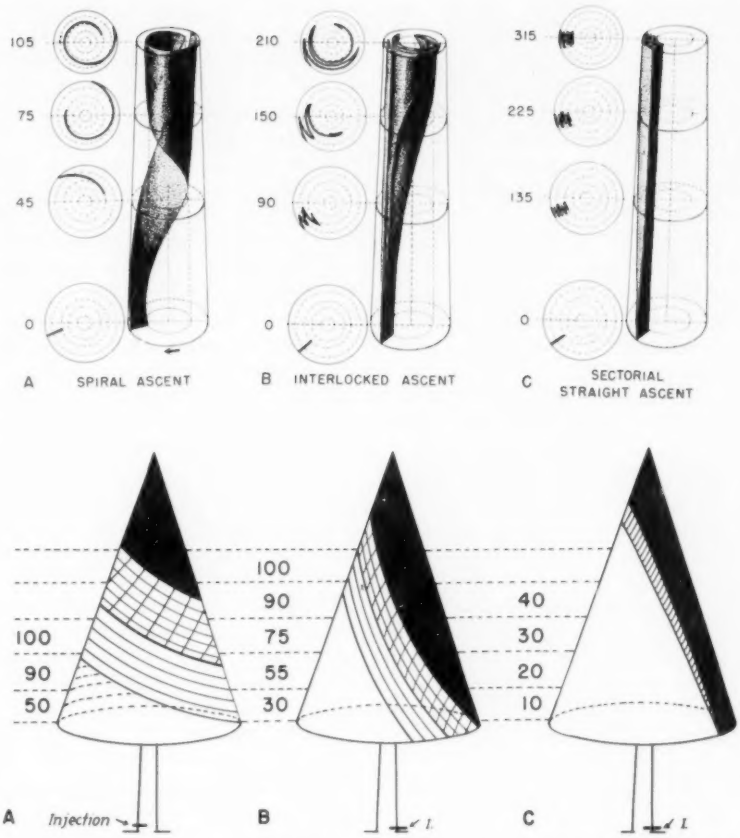

FIG. 1.—Representative types of water-conducting systems in various conifers (*upper row*) and the distribution of injected material in the crown (*lower row*). Shown is the distribution found in trees with *A* spiral ascent of water (Abies, Picea, Larix and Pinus), *B* interlocked ascent (Sequoia, Libocedrus, and Juniperus), and *C* sectorial, straight ascent (Thuja and Chamaecyparis). The figures give the percentage proportions of the branches supplied by the material in various parts of the crown. The branches supplied with the material by one growth ring are represented by a simple lined field, those connected by two rings are shown by a crosslined field, and branches connected by several rings are shown as a dark field.
Courtesy of Boyce Thompson Institute for Plant Research.

the spring, however, before the overwintering females deposit eggs, because the resulting sistens, going through a long resting, non-feeding period, do not take in the material. The same woolly aphids developing within the galls on their primary host (spruce), however, were little affected (*10*).

Among the leafminers, good control with systox was obtained against the larch casebearer when applied in the early fall before the insect constructs its case or in the spring before pupation. Fall application of systox in diesel oil against the European pine shoot moth gave complete control, as did also systox alone against *Laspeyresia pactolana* Zll. (*9*).

The time of application was found also very important in the case of leafmining weevils (*Rhynchaenus* spp.) and certain borers (*Cryptorhynchus lapathi* (L.), *Saperda populnea* L.). Control of the borer larvae by this method was possible only when the application was made before they entered the wood (*9*).

Prospects for Systemics

It is evident that systemics will not entirely replace the conventional insecticides, but it is equally evident that they will be used against certain insect groups and in situations where the latter are unsatisfactory or uneconomical. Certain important advantages in the use of systemics against forest insects are as follows:

1. Whereas the application of a nonselective insecticide to the aerial parts of plants may affect both destructive and beneficial species, the systemic insecticide absorbed by the plant may kill the injurious insects without affecting the beneficial ones. Compounds that have no toxicity to fish and game will be preferable, of course, for large-scale spray applications.

2. Systemics give protection at surprisingly low rates of application and yet result in more equal distribution. Under forest conditions, it appears that foliage application, preferably by airplane, holds the greatest possibilities.

3. New shoots and branches growing after the treatment may still be protected from insect attack by the systemic within the plant, thus eliminating frequent application. Also, the insects feeding in concealed places protected from contact insecticides, such as aphids and mites, can be reached by systemics.

4. The long-lasting effect of some materials may protect trees or seedlings longer than conventional insecticides. Also, in contrast to agricultural crops where detoxification of the material is essential before the fruit can be used, in forest trees slower decomposition may be an advantage.

5. Seed treatment before planting may protect the seedling from insect enemies for a considerable time.

Many basic aspects, however, such as tree physiology, mode of absorption, translocation, and rate of concentration of systemics and their decomposition within the tree, as well as environmental and seasonal influences on these processes, must be better understood before practical methods of application under forest conditions can be developed. Nevertheless, research to date demonstrates that systemics will have an important place in forest insect control.

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Biological Evaluation of Outbreaks of Forest Insects

J. W. Bongberg

THE FORESTS of the United States have great diversity; likewise there is great diversity in the kinds and types of destructive insects that prey upon them. Generally speaking, there are thousands of outbreaks of forest insects that occur at one place or another in the nation's forests each year. Fortunately, most outbreaks are not serious because they are brought under control by natural factors before appreciable damage has been caused. Unfortunately, however, there are many other insect outbreaks which are of very real concern because they are not short-lived and do not die out from natural causes. Instead they persist, intensify, spread and severely damage or destroy valuable forest resources over extensive areas. It is of utmost importance, therefore, that outbreaks that are innocuous be distinguished from those that are not, in order that decisions for or against the initiation or the continuation of action programs for suppression can be soundly made.

The destructiveness of an insect outbreak, be it large or small, is governed by the single or combined role of many natural control factors such as parasites, predators, disease organisms, extremes of weather, soils, host density, tree and stand susceptibility, and others. At times, the extent of an outbreak may be an influencing factor on the likely course the infestation will take. It follows, therefore, that in evaluating insect outbreaks and identifying the potentially destructive ones from those of little or no concern, the effect of one or more, or all of the natural control factors must be taken into consideration.

Evaluating the biological significance of an insect outbreak and thus determining whether or not an action program should be initiated to suppress it is seldom a simple undertaking. It is not simple because the factors to be evaluated are not simple. To evaluate them adequately requires a broad background of experience and specific information about the biology, ecology, and natural control factors of the insect species involved. It usually requires, for example, not only the identification of one or more species of parasites or predators affecting the pest population, but in addition, a measurement of their relative abundance, and an assessment of their current and potential effectiveness in checking the density of the pest insect. The biological evaluation of an outbreak also requires recognition of the occurrence, and of the prevalence and virulence of disease organisms present in the outbreak area along with a determination of the ecological relationship of the pest insect, the stand in which it occurs, and the length of time the infestation has been in outbreak status. The overall effect that these and other biological and ecological factors have or likely will have on the course the outbreak constitutes the biological evaluation process.

By and large, there are few standard methods and techniques currently available for evaluating fully the biological significance of all the many species of destructive insects which develop to damaging proportions in forest stands throughout the country. Much more research on the biologies and ecologies of the pest species and of the individual and combined role of biological and environmental factors which keep them in check will be required to develop these. Nevertheless, a vast fund of information is available about the biologies, ecologies, and natural controls of many of the more important pest species and all available knowledge is used in evaluating the significance of outbreaks before action programs are undertaken to suppress them.

The value of our forest resources has increased by leaps and bounds in the past decade or two and owners and managers of forest properties are insisting that control of destructive insects be made more commensurate with the damage and loss that insects are causing. The task of suppressing outbreaks of forest insects is increasing with each passing year. It is imperative, therefore, that accurate distinction be made between outbreaks which are or may become destructive from those which are not; and thus to assure that direct control will be applied only where and when needed to accomplish the most good in reducing damage and loss.

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The First Decade of the Pest Action Councils

Ernest L. Kolbe

In 1948 there were 1½ million acres of spruce budworm infested timber in eastern Oregon. About 500,000 acres of the infestation were classed as "heavy epidemic" with trees dying. The following year an additional million acres was infested. And the budworm had established itself in the western Oregon Douglas-fir belt.

That the budworm was a common problem was plain to all. The idea that common action was needed to control the outbreak was growing. Just the previous year Congress had passed the Forest Pest Control Act enabling cooperative action. So we in the Northwest developed a plan that was simple and practical, and one that furthered cooperative effort because it was easily explained and understood. We banded together a "Budworm Action Committee" composed of private, state and federal foresters, and landowners. With this group, representative of state, federal and private organizations, we organized and carried out an action program against the budworm.

The first spray had hardly settled on the budworm hordes when other pest problems began to claim similar concerted attention. There were other destructive insects, and also diseases, porcupine and bear—all troublesome enough to justify investigation. Too, there was deep interest in research as a basis for getting better control and understanding of the problems. It was quite natural therefore, for the bud-worm group to broaden its membership and take on the new problems under the new name of the Northwest Forest Pest Action Council. Thus the Pacific Northwest cradled the forest pest action council movement which soon spread to other areas. There are now six councils in western states, eight committees in eastern states and one in British Columbia.

The councils organize and operate according to regional needs. No two are exactly alike, yet their objectives are the same. They enable forest owners and managers to take coordinated action against forest pests. Under the pest action council system forest owners and public agencies do not relinquish any of their responsibilities for protecting the land under their management.

The Northwest Forest Pest Action Council is an example of how councils work. It has no formal membership. Anyone interested in protecting the forest is invited to participate. The council is not a control agency. Instead, it is a catalyst. It consolidates thinking, planning and action. Before council organization, pest problems were handled pretty much on a localized, individual basis. Each owner, each manager, each researcher went his own way until some crisis developed; then came a desperate scramble to improvise action. That is all changed now. The council with its broad representation of interest makes sure first that pest problems are fully examined and understood by all concerned. Projects of real merit survive such scrutiny, and control decisions are sure of powerful, unified support.

Most of the work of the council is done through work committees consisting of individuals particularly interested in a special problem. The committees are formed as problems develop and they disband as they are solved. Such problems as those created by the spruce budworm, the Douglas-fir beetle, the silver fir beetle, the balsam wooly aphid, tree diseases, and animal pests, as well as research needs all have had special committees.

Listing of council accomplishments is most difficult because they are, to a large extent, intangible. Other hands do the actual work of detection, control, and research—but back of them all stands the council, coordinating, helping, pushing, seeing to it that jobs needing to be done are done. Some major achievements can be outlined as follows:

1. The councils have aroused public interest in and support of forest pest control.
2. They have strengthened forest pest detection by stimulating volunteer observer service and by acting as a clearing house for survey findings.
3. They have done special survey and research jobs.
4. They have interested the chemical industry in pest control as a potential market for chemicals.
5. They have stimulated increased training in forest protection in the colleges; as a result there have been added curricula and special short courses.
6. They have stimulated research on a priority basis by reviewing needs and recommending action.
7. They have played the major role in getting control projects under way.

Without question, the councils' activities have saved landowners and taxpayers in general large sums of money. And best of all, the councils have played a leading part in saving from destruction billions of feet of timber.

Important among the benefits are the lessons learned by trial and error over the past ten years. For example, through the council organization, we have learned that detection surveys and economic studies are useful only when we know a control program will follow. It does little good, for example, to use emergency funds to learn in detail about an insect or disease and then have no measure or procedure to stop the losses.

One of the most important lessons learned was that we need to

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anticipate the benefits of a control program before embarking on it. In other words, we need to know whether the dollars expended will be offset by the trees saved. Involved in this of course is an estimate of the trees that would likely survive without control. All this calls for close coordination between landowners, timber experts and insect or disease specialists.

Armed with such information, the landowners, the foresters and the technicians, through the councils, determine the advisability and priority of control. As a result, the councils assure strong support for well planned and agreed upon programs.

The first ten years in pest action council work has been mainly devoted to getting important control jobs accomplished. From now on the councils will be looking into means of achieving greater efficiencies in all phases of detection, evaluation, control, as well as related research. The councils are looking at the big job coming up on disease and animal control. The councils will be active in the field of biological controls. The councils will give more attention to cultural techniques in forest stands that may be used in preventing outbreaks.

This report has confined itself to the councils and their role in meeting pest problems. It should be mentioned that all the western councils report annually to the Forest Pest Committee of the Western Forestry and Conservation Association, whose cooperative influence helps shape action programs. In earlier years there was also the Forest Pest Consultants Committee of the U. S. Secretary of Agriculture. When it went out of business there was widespread concern that national guidance on pest control matters was essential. So the industry formed a Forest Pest Committee in the Forest Industries Council, now functioning at the national level.

It is clear that the pest action councils provide a forum for bringing together the viewpoints and knowhow that will bring about cooperative action against the common enemy. Looking back over the road pest action councils have traveled in their first decade of operation makes us aware that outstanding progress was made in saving forests from pests. The future looks even brighter. The outlook is for more effective chemicals and for greater biological control through parasitic and predacious insect enemies. However, this will require finding solutions to many problems by our forest researchers if we hope to reduce the losses by destructive agents to tolerate limits.

A "Program for the National Forests" Submitted to Congress

Under date of March 23 Secretary of Agriculture Benson submitted to the President of the Senate and to the Speaker of the House of Representatives a proposed "Program for the Development of the National Forests."

In his letter of transmittal the Secretary called attention to the fact that he in 1956 asked the Forest Service to develop a long-range conservation program for national forest resources. The first result was the five-year program initiated in 1957, called "Operation Outdoors," aimed at reconstruction, rehabilitation, and adequate maintenance of the then existing recreation facilities on the national forests.

This new comprehensive program, the Secretary stated, ". . . embraces all the renewable resources of the national-forest system—water, timber, recreation, forage, and wildlife habitat. It includes both long-range objectives and interim proposals. The program provides for the continued, orderly use and development of the renewable resources of these Federal lands in accordance with the basic conservation principles of sustained yield and multiple use."

Noting the need for the program, the Secretary pointed to the ". . . mounting and competitive pressures for national-forest resources."

Legislative authorities for the recommendations are generally adequate, he said. Supplemental legislation will be proposed as the need arises and implementing appropriation requests submitted in future years ". . . after due consideration of the overall fiscal needs and resources of the Federal Government."

Recommendations regarding individual resources of the forests (as classified in the report) are covered by long-range objectives, related to the year 2000, and a short-term program for the next 10 to 15 years, aimed toward meeting current needs and attaining the long-range objectives.

Book Reviews

World Timber Trends and Prospects

By Thorsten Streyffert. 246 pp. Illus. Almqvist and Wiksell, Stockholm, Sweden. 1958. $7.73.

In *World Timber Trends and Prospects* Dr. Streyffert attempts to forecast future timber supplies and requirements on a worldwide basis. The first two chapters consist of an examination of the demand and supply aspects of the world forest situation. Chapters III and IV contain an analysis of past trends in the consumption of forest products and develop estimates of future requirements. The rest of the book is largely a discussion of the forest resources of the world by regions and their ability to meet expected requirements.

Dr. Streyffert has been professor of forest economics at the Royal School of Forestry in Stockholm since 1939 and its dean since 1947. He has written several books and many articles on forest economics, has traveled widely, received honorary degrees in Sweden, Finland, and Germany, and is known internationally for his work in forestry.

Professor Streyffert estimates that year 2000 industrial wood requirements of the world, excluding the U.S.S.R., will be about 1.03 billion cubic meters (36.4 billion cubic feet), 75 percent greater than the average annual consumption in 1950-1952. This estimate is based on current trends and many assumptions. The chief assumptions are that the price of wood in relation to other raw materials will be fairly constant, world population will increase 32 percent, per capita use of constructional wood will change little whereas per capita use of wood for pulp products will double, and about 77 percent of the demand will continue to be for softwoods. The U.S.S.R. is omitted because its forestry policies, based on political aims, are unpredictable.

By regions, per capita use of constructional wood is expected to decrease in the United States and Canada, remain unchanged in Europe, Japan, and Oceania, and double in the rest of the world. Per capita use of pulp products is expected to increase at the rate of 0.7 percent compounded annually in the United States and Canada, 1.5 percent in Europe, and 2.7 percent in the rest of the world. Although per capita use of all industrial wood is expected to decline in the United States and Canada and increase in the rest of the world, the United States and Canada probably will still account for 51 percent of the world (excepting U.S.S.R.) consumption in the year 2000, compared with 55 percent in 1950-1952.

Half of the industrial wood now comes from virgin forests. The greater requirements for wood in the year 2000 are expected to be met largely by improved forest management of presently accessible forests and by reducing waste, rather than by any great increase in the area of accessible forests. Greater yields per acre are anticipated, largely in the coniferous forests of Europe and North America. Only a gradual increase is foreseen in the use of hardwoods and exploitation of hardwood forests, even though two-thirds of the world's forest area is hardwood, largely tropical.

Dr. Streyffert draws heavily on the statistics and studies published by the Food and Agriculture Organization of the United Nations. Organization of the book and the tables are excellent, but the text abounds in alternatives, possibilities, and qualifiers, and is by no means light reading.

On page 11, the American converting factors are a little confusing, because of the mixture of English and continental use of commas and periods. Since the English use was intended, 1 metric ton equals 1.102 short tons, not 1,102, and 1 standard equals 1,980 board feet, not 1.980. Further, 1 cubic meter of stacked wood equals 0.28 cord, not 0.33.

ALBERT A. DOWNS
U. S. Forest Service

Green Power

By James Stevens. 95 pp. Illus. Superior Publ. Co., Seattle, Wash. 1958. $3.

Jim Stevens, the author who will go to battle for a tree—any tree—has written his 10th book, "Green Power." The theme hinges on cooperative federal-private working circles, and there is a rundown on how forest policy developed from William Penn's "save one acre in every five for the community" to Sen. Charles L. McNary's Public Law 273 setting up the cooperative working circles.

The book comes at a time when both the working circle idea and "wilderness" issues are warm on the political front, but Jim carefully shies away from mentioning politics.

Interesting history and forest policy lore appear, ranging from Thomas Jefferson's decision to base surveys on section, township, and range, and Benjamin Harrison's national forest reserve act, to Grover Cleveland, who added 21,279,000 acres to the forest reserve. Theodore Roosevelt, who is given credit for the "stability of the community" policy, and on through the first fire protection joint action law under William Howard Taft, and Woodrow Wilson's expanded forest service.

He touches on a number of forest greats both ways from Pinchot. But it is McNary's Public Law 273 that

holds the book together. As is pointed out by Stevens, it has resulted in busy, permanent cities in lieu of threatened ghost towns in Washington's Grays Harbor area where Law 273 has had its most important workout.

He also makes an interesting point by comparing the huge forest loss of Oregon's famed Tillamook burn with a more-than-equal amount of timber taken from the realm of timber management by Washington's huge Olympic federal "wilderness" alone. Jim says nothing about reading between the lines, but many interested readers will do so while enjoying the ardor of Stevens-type forest writing.

Lamar Newkirk
Oregon Journal
Portland, Oregon

Analytical Photogrammetry

By Everett L. Merritt. 242 pp. Illus. Pitman Publishing Corp., New York. 1958. $7.50.

As implied by the title, *Analytical Photogrammetry* is not rapid reading. Yet it is concise and well organized, and the man interested in forest photogrammetry who has a good mathematical background should find this book of interest. It should also be a useful reference for teachers of forest measurements.

The first chapter of 37 pages on "Fundamental Concepts" illustrates that the author reached the objective stated in his preface: ". . . to free the reader from any specific viewpoint other than a general understanding of the basic problems of photogrammetry . . . whereby he is equipped to cope with any problem or to evaluate any system without the mental blocks of apperception." Starting with projection of a point to a line and to a plane, the discussion, diagrams and equations cover such items as: orthoprojection of an object to a plane, and projections for different relative positions of image and object planes. The last sections in the chapter are "Application of Perspective to Interior and Exterior Orientation of Exposure Station" and "Uses of Analytical photogrammetry." The remainder of the book will probably be of particular interest only to specialists in photogrammetry, such as those engaged in geodetic mapping.

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Compiled by Martha Meelig, *Librarian, State University College of Forestry at Syracuse University*

Range Management Section Compiled by Nellie G. Larson, *Library, U. S. Department of Agriculture*

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Council's Column

The Forester and the Society of American Foresters

What do I get for the dues which I pay to the Society of American Foresters? This question is often asked, particularly by the younger foresters. Their concern is, what does the Society do for me?

Who is the Society of American Foresters? It is you, and I, and every professional forester who is a member. So you get out of the Society yourself in proportion to what you put into it. That can be very great. As a matter of fact it is probably much more than foresters realize without some careful thought on the history and development of forestry in this country.

One of the features which distinguishes a profession from a trade is that a profession includes, and its members accept, a responsibility to society. This principle has long been recognized by the medical profession, the profession of law, and by the engineers. It is certainly inherent in the profession of forestry. Therefore everyone getting a professional degree in forestry has a duty to apply his knowledge to serve the objectives of ownership and to outline for ownership the relationship of management to the interests of society. Forest land is a resource upon which not only the present generation but all generations

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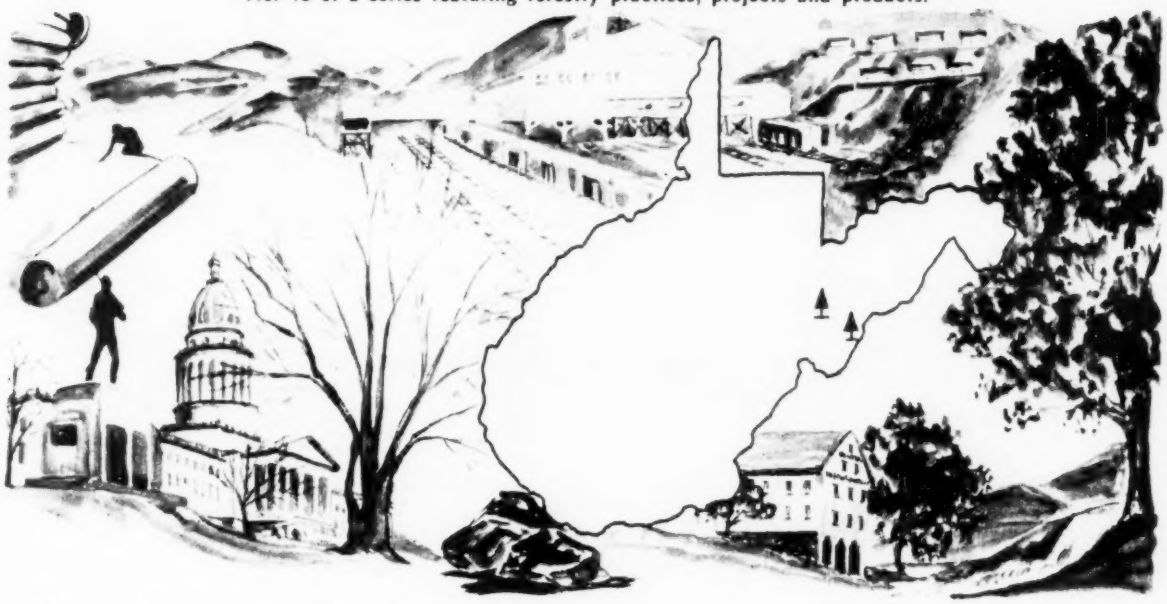

PAPER OR PULP MILLS NATIONAL FORESTS

West Virginia

Montani Semper Liberi, West Virginia's state motto, means that mountaineers are always free. The earliest white settlers, including such famous frontiersmen as Daniel Boone and the Wetzels, were men who loved freedom and found it in the new land across the Allegheny Mountains.

The fine virgin hardwoods, red spruce, white pine and hemlock seen by these pioneers gave way before the swinging ax in the late 1800's and volumes of as much as 40,000 board feet per acre were harvested. Records show that in 1909 1,473,000,000 board feet were hewn from the virgin forests and reached fine wood markets throughout the world.

Fires reported to have burned up to 15 feet into the earth, added to this ravage.

The state did not become concerned, however, until 1901 and then only moderately so. In that year, a chief forest warden was appointed to serve without staff or money. Progress was slow until 1921 when a chief forester was appointed and more money was made available by the state.

In 1933, the present title of State Forester was adopted, and programs were increased to include forest administration, cooperative forest management, nurseries and reforestation, watersheds and flood prevention.

West Virginia leads the nation in the production of soft coal, but, while the harvesting of forest products isn't the most important industry today, those who know the timber industry predict that some day forest products will have the number one rating.

Today, one out of every ten employed persons earns a livelihood from the forest. An estimated 437,650,000 board feet of sawtimber was harvested during 1957, and annual growth now exceeds harvest. Through the coordinated efforts of government and landowners, well stocked and properly managed forests of the future should exceed production of virgin forests.

West Virginia was one of the first two southern states to pass enabling legislation for the establishment of national forest reserves. A $5,000 appropriation was passed by the state legislature in 1913 for the protection of forests, and a contract signed with the federal government for a similar amount. Two national forests, the Monongahela and a portion of the George Washington, are now within the state's boundary.

Nine state forests totaling some 80,000 acres, on which timber sales began in 1954, are administered on a multiple-use basis. Many of the forests are excellent public shooting areas and all provide recreation and watershed protection.

Forest management assistance to private landowners is limited by the number of technical foresters available. There is close cooperation with private industry. Tree seedlings are produced and distributed for planting on private land for all purposes except ornamental.

Except for the southern one-third of the state, forest fires and damages are reasonably low. In the southern third, problems of absentee ownerships, rugged terrain (93% of one county is in slopes exceeding 40%!) and a high concentration of industrial employment keeps the fire menace too high. Although positive progress is evident in the last few years, the area is still known as part of the "hot spot" of the East.

Through the combined efforts of all state and federal agencies concerned with land management and with the interest demonstrated by the landowners, the future of forestry in West Virginia is becoming brighter.

W.Va. Conservation Commission — *contribution to this series does not necessarily constitute endorsement of Southern Glo products.*

Difficult terrain is one of the conditions that points up the convenience of SOUTHERN GLO tree marking paints. Often the forester can mark accurately by "shooting" where uncertain footing makes tagging or blazing impractical.

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yet to come must depend for a living. The forester has a duty to today and to tomorrow.

I doubt that a forester can discharge this duty most effectively by himself alone. That has been the expedience of other professions over the years. Each one has felt the need of a professional society. A forester really needs a professional society in order to enable him to merit public confidence and best practice forestry. Let us look for a moment at some of the things that have been performed by the Society. Consider their importance to us and to the future.

Could you individually bring about a high standard of forestry education in America? Isn't that essential to maintain the esteem or the prestige of your profession to give you a basis on which the public and land owners generally are willing to pay for your services? Your Society has been a strong force for the improvement and development of a continually increasing standard of forestry education in America. The accreditation committee has reviewed curricula and consulted with many schools. This professional society as a whole has been a force to convince college management of the importance of its forestry curricula and of implementing it to provide a high degree of forestry education. Some years ago the Society sponsored a study of forestry education by Graves and Guise and most recently has through its professional stature been able to obtain from the Old Dominion Foundation a grant of money to make a new study of forestry education in this country.

Could you individually gather together the experience of many practicing and research foresters to help you grow with the profession and be better able to serve the owner and society? The Society makes available through the JOURNAL OF FORESTRY, Forest Science, and the Forestry Handbook, to name just a few, the current and past experience of many men. We owe a great debt of gratitude to the many men who have served and are serving as associate editors to review manuscripts and bring them together for publication and to make them available to all of us.

Your Society through its far-flung organization of Chapters and Sections provides a framework for meetings at which ideas are exchanged and acquaintances made. The national Society, Sections, and some Chapters have committees which are at work to bring together information which will be of value to every professional forester. An example, to name just one, is the Soils Manual prepared by the Columbia River Section Committee on Soils—a really fine achievement, bringing together much information which will help foresters in the days ahead.

Forestery in America enjoys a stature which would never have been possible had it not been for the organization and activities of our professional Society. This isn't something that just happened. It isn't something which foresters individually brought about. It has been attained through collective effort of all foresters working through their professional organization.

So, to go back to the question "what do I get from the Society?", it seems to me that I get some nourishment for my professional interest. I am sure that I get it in proportion to my effort and desire to get this nourishment. It can be great. It can be small. I have been increasingly convinced over the years that I can better meet my responsibility as a professional man because there is a Society of American Foresters. A forester may bask in the sun of the accomplishments of the SAF, but better yet, he can join with his colleagues to share with them in continuing to build the profession which he is practicing. I hope we will never stop growing, for if we do I think our profession will be a dying one. We must build this profession and continue to strengthen it, so that foresters in the future will be better able to meet the more complex and challenging problems which they will face with the increasing pressure on resources. It is pure speculation, but I wonder sometimes where we would be today, all of us, what would be our status, if Gifford Pinchot and the six other Charter Members had not met together in 1900

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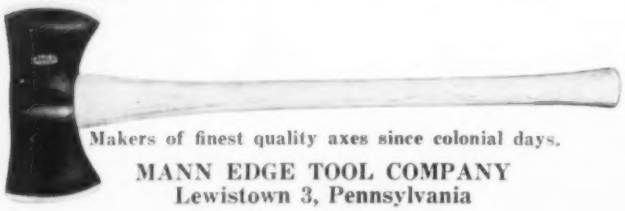
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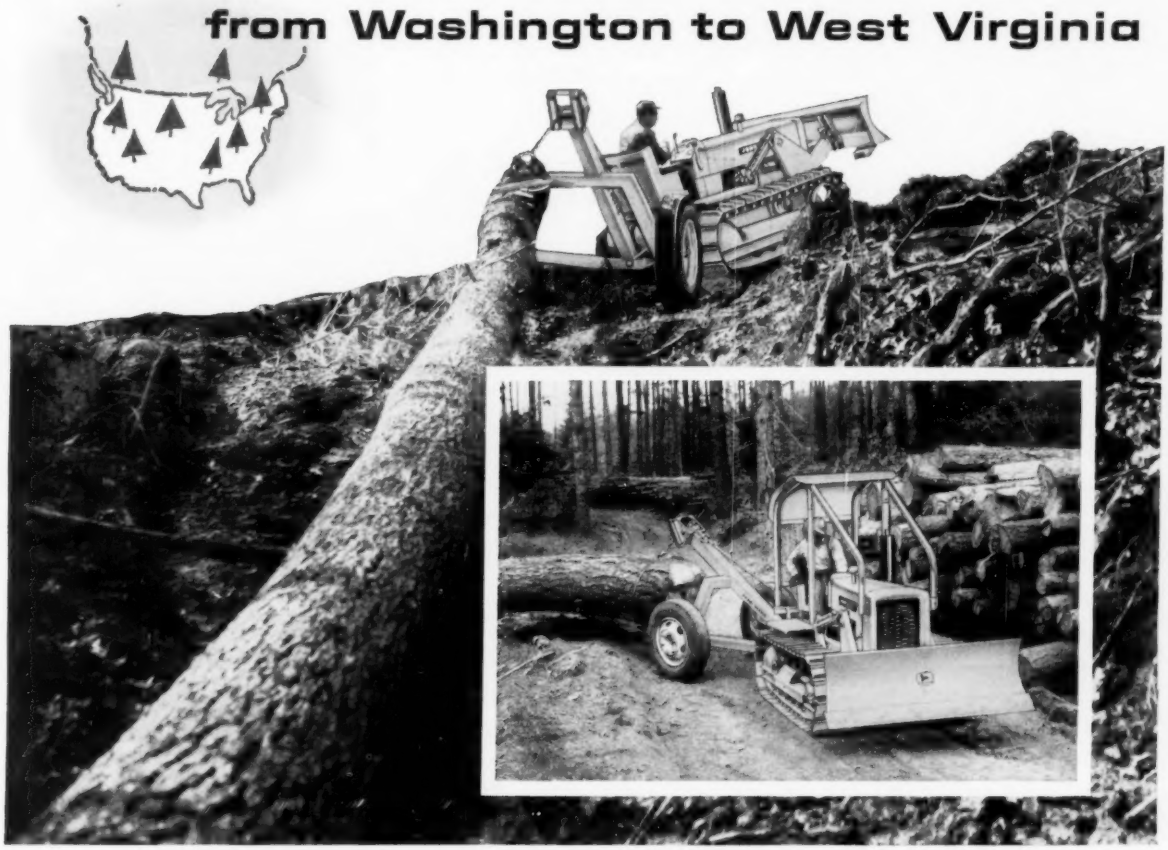

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and agreed to pool their efforts to promote objectives which are those of our Society. Did they ask, "What am I going to get for my dues?"

J. HERBERT STONE

William W. Jolly (1908-1959)

William Warren Jolly, chief, Forest Economics Section, Division of Forestry Relations, Tennessee Valley Authority, died of a heart attack in Knoxville, Tenn., March 1.

Mr. Jolly was born in Yankton, S. Dak., November 25, 1908. He graduated from the University of Minnesota in 1933 with a BS degree in forestry.

Before joining the TVA forestry staff in January 1934, he worked for the U. S. Forest Service on two national forests in Minnesota and for the Civilian Conservation Corps.

Throughout his employment with TVA, he spent practically full time on forest resource and industry surveys. He became chief of the Forest Economics Section in 1942. He did early pioneer work in estimating forest drain and in improving the techniques of using aerial photographs in forest survey work.

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Third Call for Council Nominations

All members are hereby notified that the regular biennial election will be held December 5, 1959. A president, vice president, and nine other members of the Council will be elected for the two-year term 1960-1961.

The present Council is listed on page 294. Any or all of these incumbents may be renominated, provided they accept the nomination in writing.

Membership on the Council is restricted by the Constitution to Members (formerly Senior Members) and Fellows. Any Member or Fellow is eligible to hold office who is in good standing and who accepts the nomination in writing and declares his willingness to serve if elected.

Each voter will have an opportunity to ballot on all candidates for office. Council members are elected in accordance with the system of proportional representation. The procedure of proportional representation will be explained in a later issue of the JOURNAL. It is the system by which the Society has been electing Council members for more than two decades.

Table 1, page 136 February issue, shows distribution of Council members by states 1944-1959.

Candidates for the office of president are voted on separately; the candidate who receives the highest vote is declared elected president, and the candidate who receives the next highest vote is declared elected vice president. Thus all candidates for president are considered as nominated also for vice president.

How Nominations Are Made

The Constitution (Article VIII, Section 2) states the conditions under which nominations are made by petition.

1. Each petition shall name but one candidate.

2. All candidates must be eligible to hold elective office.

3. A petition shall bear the signatures of at least ten voting members who at the time of signing the petition are eligible to vote in the coming election. (Eligible voting members are Junior Members, Members, and Fellows in good standing.)

4. A voting member may not sign more than one nominating petition for president or more than one nominating petition for a member of the Council. That is, he may sign two, but no more.

5. Petitions must be in the Society office by September 19, 1959.

The Society has no special form for submitting nominating petitions. They may be written as follows:

We, the undersigned voting members of the Society of American Foresters,

hereby nominate John Doe, a Member (or Fellow) for the office of president (or member of the Council) for the two-year term 1960-1961.

No nomination will be considered valid unless supported by the nominee's acceptance in writing.

The form of acceptance of a nomination may read as follows:

"I accept the nomination to the office of President (or to membership on the Council) of the Society of American Foresters for the two-year term 1960-1961, and agree to serve if elected."

All nominating petitions should be sent promptly to the Society office, 425 Mills Building, Washington 6, D. C. The executive secretary will gladly provide information about nominating or election procedure.

According to the Constitution (Article VIII, Section 1) a Nominating Committee has been appointed by President Garratt. The Committee is composed of the following members:

Chairman, Harry Wm. Dengler, Extension Service, University of Maryland, College Park, Md.

Earl J. Adams, 4705 Tenth Avenue South, Minneapolis 7, Minn. (State Division of Forestry.)

Robert R. Milodragovich, U. S. Forest Service, Cody, Wyo.

Harry M. Roller, Jr., Woodlands Department, International Paper Company, Mobile 9, Ala.

George Stenzel, College of Forestry, University of Washington, Seattle 5, Wash.

This committee is charged with the following duties:

1. To set the date of the election. (December 5, 1959, is the date.)

2. To provide for at least two candidates for the office of president, and at least nine candidates for membership on the Council.

3. To receive separate nominating petitions for the office of president and for each member of the Council, and to supplement such petitions when necessary with other nominations in order to comply with item 2 above.

The Nominating Committee will make no nominations of its own unless the voting membership fails to make the required minimum number of nominations by petition. Voting members should accordingly get busy and make their own nominations.

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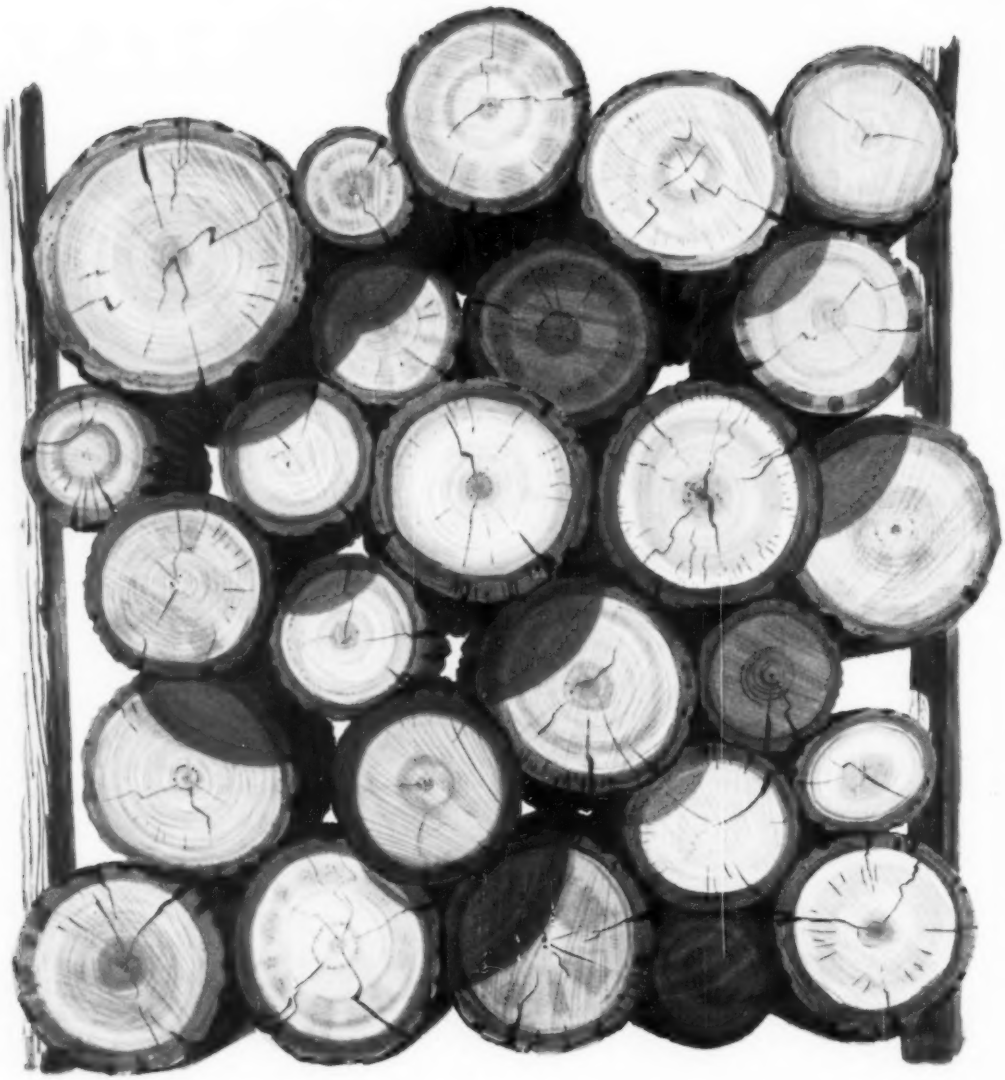

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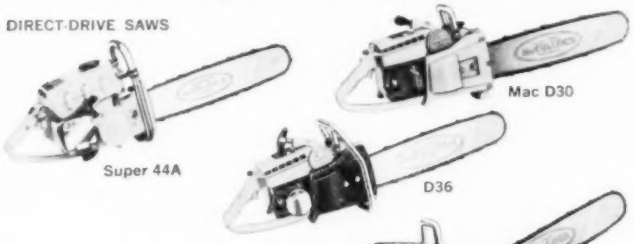

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Nominations Received

On the date of going to press the following nominations had been received:

For President

Henry J. Malsberger, Atlanta, Ga. (Vice president 1958-1959.)

For the Council

William C. Bramble, Lafayette, Ind.

George A. Garratt, New Haven, Conn. (President 1958-1959.)

W. D. Hagenstein, Portland, Ore. (Council member 1958-1959.)

HARRY WM. DENGLER, *Chairman*
Nominating Committee

Third Call for Fellow Nominations

All Members (formerly Senior Members) and Fellows of the Society are hereby advised that nominations for the grade of Fellow are now open. The election of Fellows will be held at the time of the Society's regular biennial election, December 5, 1959.

As defined by the Constitution (Article III, Section 7), "Fellows shall be foresters recognized generally throughout the profession as persons who have rendered outstanding service to forestry and to the Society. They shall be elected from the Members."

Nominations by Petition

The procedure for placing Members in nomination for the grade of Fellow is by petition. The Society has no printed form for this purpose; the petition may be typewritten thus:

We, the undersigned Members and Fellows of the Society of American Foresters, hereby nominate John Doe for election to the grade of Fellow in 1959.

Remember these simple rules:

1. A petition may not name more than one candidate.

2. It must be signed by not less than 25 Members or Fellows in good standing.

3. It should be accompanied by a factual, not eulogistic, biographical sketch of at least 300 words giving an account of the nominee's professional career and accomplishments.

4. It must be received in the execu-

tive office of the Society in Washington, D. C., not later than September 19, 1959.

The executive employees of the Society cannot be responsible for obtaining signatures on partially completed petitions or on petitions incomplete by reason of unacceptable signatures (that is, signatures of other than Members and Fellows in good standing).

Election Procedure

Fellows are not elected by the membership at large, but by a board of electors which consists of all present Fellows, the Council, the chairmen of the 21 Sections, and the chairmen of the 9 subject Divisions.

The system is described in Article IV, Section 4 of the Constitution. To win election a nominee must receive an affirmative vote of not less than one-half the total number of votes cast, as provided in Bylaw 11.

For the 1959 election there will be 128 electors, of whom 88 are Fellows. An elector has one vote only. A Fellow who is also a Council member has but one vote.

Significance of the Grade

The highest membership distinction that can be conferred by the Society, this grade is awarded in recognition of outstanding service to forestry and to the Society. Fellows do not pay increased dues; their dues are the same as those of Members.

Since the Society was founded in 1900, there have been 125 Fellows elected. At the present time the number of living Fellows is 88.

Since the last election in December 1957, three Fellows have died: S. R. Gevorkiantz of Minnesota, J. S. Holmes of North Carolina, and F. W. Morrell of Virginia.

A list of the current fellows was published in the February issue of the Journal.

Fellow Nominations

On the date of going to press the following Members had been nominated for the grade of Fellow:

Bishop F. Grant, Athens, Ga.

Coming Events

Southern California Section

The spring meeting of the Southern California Section will be held on April 10 and 11, with headquarters in San Diego.

Columbia River Section

The spring meeting of the Columbia River Section will be held on April 18 at Eugene, Ore.

Gulf States Section

Plans have been made for the annual meeting of the Gulf States Section to be held May 7-8, in Tyler, Texas.

Northern California Section

A field meeting of the Northern California Section will be held on June 5 and 6 in the Santa Cruz area.

Southern Tree Improvement Conference

The fifth Southern Tree Improvement Conference will be held June 11-12 at North Carolina State College, Raleigh.

Northeastern Forest Tree Improvement Conference

The seventh annual Northeastern Forest Tree Improvement Conference will be held at the University of Vermont, Burlington, August 18-19.

Lake States Forest Tree Improvement Conference

The Fourth Lake States Forest Tree Improvement Conference has been scheduled for October 6 and 7, at the University of Michigan, Ann Arbor.

Society of American Foresters

Annual meeting—November 15-18, San Francisco, Calif.

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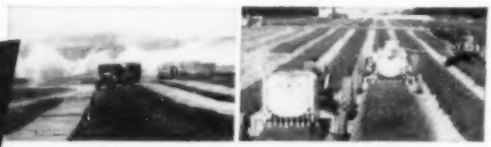
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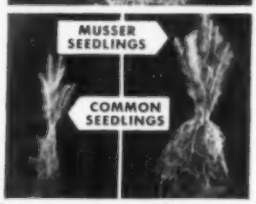

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Kentucky Foresters Are Hosts to Section

Foresters from three states convened at Mammoth Cave National Park January 30-31 for the annual winter meeting of the Kentucky-Tennessee Section. More than 100 persons from these two states and northern Alabama attended the two-day session.

Harry Nadler, associate director of the Division of Forestry, and Park Superintendent Perry Brown welcomed the group to Kentucky and Mammoth Cave. Sessions were devoted to discussions of the problems of small woodland properties and the solutions for those problems.

Speakers at the annual banquet were George A. Garratt, dean of the Yale University School of Forestry and president of the Society, and Seth Jackson, veteran of 26 years in the Forest Service and a member of the U. S. Delegation to the FAO/ECE meeting in Russia in 1957. Jackson's talk on Russian forests and logging was illustrated with colored slides.

William Dewey Gorman, Hazard (Ky.) businessman, and Hugh D. Faust, Jr., Knoxville, (Tenn.) tree farmer received the Section's 1958 Forestry Recognition Awards. Plaques are awarded each year to the laymen in the two states whose work in forest conservation is adjudged most outstanding.

At the business session new officers were installed. They were Erwin G. Wiesehuegel, Norris, Tenn., chairman; Thomas F. Ramke, Chattanooga, Tenn., vice-chairman; and Malcolm J. Williamson, Berea, Ky., secretary-treasurer.

Appalachian Section Holds Big Annual Meeting

With an attendance of 375 members and guests the Appalachian Section held its largest annual meeting on February 6 and 7 at Columbia, S. C. W. F. Millikin was chairman of the Committee on Arrangements.

"Timber Supply, Growth, and Drain" was discussed by James McCormack of the Southeastern Forest Experiment Station, Henry J. Malsberger of the Southern Pulpwood Conservation Association, Howard Doyle of the Furniture, Plywood, and Veneer Council, and H. F. Bishop, consulting forester.

A panel discussion on this subject followed with Ralph C. Bryant of North Carolina State College as moderator. Panel participants were C. H. Niederhof of West Virginia Pulp and Paper Company; Stuart Keedwell, consulting forester; John Gray, North Carolina extension forester; and Joseph Pechanec, U. S. Forest Service.

Marlin H. Bruner served as toastmaster at the Section's dinner in the Wade Hampton Hotel when F. X. Schumacher of the Duke University School of Forestry received the Section's achievement award. Entertainment was offered by Columbia College Music Department. The after-dinner speaker was Harold S. Reeves of Charleston, S. C.

Chairman H. F. Lathrop presided at the Section's business session. Reports were presented by the various Section committees, including Vice

Officers of the Society and of the Appalachian Section at the Section's meeting in Columbia, S. C., February 6 and 7. *L.* to *R*, Henry J. Malsberger, SAF vice president; Section vice chairman, Robert M. Osborn; Section chairman, Walter T. Ahern; Section secretary, Norbert B. Goebel; Section executive committeemen, L. E. Chaiken and H. Freeman Lathrop; Henry Clepper, SAF executive secretary.

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Chairman E. S. Harrar's report on membership and Secretary-Treasurer Walter T. Ahern's report on finances. C. F. Korstian reported for the Section's Committee on Natural Areas. Executive Secretary Henry Clepper discussed national Society affairs.

New officers elected to serve during 1959 are:

Chairman, Walter T. Ahern.

Vice Chairman, Robert M. Osborn.

Secretary-Treasurer, Norbert B. Goebel.

Members of Executive Committee: L. E. Chaiken and H. Freeman Lathrop.

The charter for the Section's newly established Rappahannock Chapter was formally presented by David V. Smith to J. H. Johnson. Officers of the new Chapter are: Chairman, Calvin F. Glattfelder; Vice Chairman, Pete Straight; Secretary-Treasurer, John N. Graff.

Washington Section Holds All-Day Meeting

Departing from its usual practice of evening meetings, the Washington, D. C. Section held an all-day session on February 19. Chairman Kenneth Pomeroy presided.

The 170 members and guests in attendance heard four panel discussions: "Views on the Use of Chemicals in Forest Management" was moderated by James B. Craig, *American Forests* editor. W. V. Benedict, U. S. Forest Service, and James DeWitt of the Fish and Wildlife Service made up the panel.

"The Trend in Forest Inventory Systems" consisted of papers by Theodore C. Tyron, consulting forester, Calvin B. Scott, and Austin Hasel, Forest Service. Richard C. Wilson moderated the discussion.

The "Stature of the Forestry Profession in the United States" was explored under the direction of James McClellan of AFPI. Zebulon T. White, Yale, N. T. Barron, Union Bag-Camp Corp., and Lynn E. Correll of the Forest Service were panel participants.

"Current Problems in Government-Forest Industry Relations in the East" received the attention of D. E. Hess, Glatfelter Pulp Wood Co., Edward Stuart, Jr., consulting forester, Roy Olson of the Forest Service (whose paper was read by Gordon Mark), and H. C. Buckingham, Maryland state forester.

At the noon luncheon SAF President George Garratt reported on his visits to Section meetings, discussing trends apparent in Section programs and matters brought up for attention of the profession. Arthur W. Nelson, Champion Paper and Fibre Co., delivered an address entitled "Forestry For Profit—The Challenge Facing the Industrial Forester Today."

Over half of the principal participants in the day's program were visiting foresters from other Sections.

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New York Section Hears Chemoforestry Talks

The 1959 winter meeting of the New York Section was held on January 29 and 30 at the Hotel Onondaga in Syracuse. The meeting, featuring the business session as an opener on January 29, was the best attended winter meeting in the history of the Section. James F. Dubuar was elected vice chairman and Edward J. Whalen to the Executive Committee.

Dr. Frank Egler, setting the theme of the meeting, spoke on the subject of "A Biologist's View of Chemoforestry and the Public Welfare." Two panel groups presented papers:

1. "New Developments in Forest Pesticides," with John W. Stock, moderator. Papers were presented by Dr. D. A. Collins, state entomologist, Albany; Dr. H. H. Schwardt, Entomology Department, Cornell University; J. S. Yuill, Forest Insect Laboratory, Beltsville, Md.

2. "Recent Developments in Silvicides and Chemical Fertilizers in Forestry." Prof. S. O. Heiberg was moderator. Papers were presented by Francis M. Rushmore, Northeastern Forest Experiment Station; David B. Cook, New York Conservation Department; Dr. Robert R. Morrow, College of Agriculture, Cornell University; Dr. Albert L. Leaf, College of Forestry, Syracuse.

A discussion period followed each panel.

Dean Hardy L. Shirley of the College of Forestry at Syracuse presented an illustrated talk on the development of industries and social and engi-

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OFFICERS and members of the executive committee of the New York Section. They are: Samuel R. Parmelee, chairman; James F. Dubuar, vice chairman; Shelley W. Potter, secretary-treasurer; Raymond R. Benson, William Rutherford, and Edward J. Whalen, members of the Executive Committee; and Ralph G. Unger, past chairman. The photo was taken at the Section's meeting, January 29-30, in Syracuse, N. Y.

and who meet the requirements of the Section's Student Loan Committee are eligible to receive loans of $250 or more per year. Size of loan and requirements of repayment are determined by the committee on the needs and merits of each individual case.

Members of the committee are E. R. Buckner, Conro Olive, John F. King, J. A. Newman, E. G. Wieseheugel, and H. E. Murphy. Loan applications may be submitted to any member of the Section, to be then transmitted to the committee.

James F. McCormack (1913-1959)

James F. McCormack of Asheville, N. C., died February 26 following a heart attack. He was 46 years of age.

Mr. McCormack was head of the Forest Economics Division of the Southeastern Forest Experiment Station at the time of his death. He had been with the station since 1945, having transferred there from the Clark National Forest in Missouri, his first Forest Service assignment.

Mr. McCormack joined the Forest Service in 1935 after receiving his B.S. degree from Cornell University that year. He was born February 23, 1913 in Ithaca, N. Y.

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Friday morning's session was also devoted to two panel groups. The first, under the chairmanship of Frank Wardell, covered the general topic of "The Significance of Chemoforestry to Wildlife Management." Panel members were Dr. William L. Webb and Dr. Roy Hartenstein of the College of Forestry, Syracuse, and Dr. Gus Swanson of the Department of Conservation, Cornell University.

Floyd E. Carlson was moderator of the second panel covering the subject "Chemoforestry — Its Opportunities and Problems." Speaking on this subject were Thomas McConkey and Albert G. Snow, Jr., of the Northeastern Forest Experiment Station, and Hon. Samuel T. Betts, III, Assistant United States Attorney, Syracuse.

Kentucky-Tennessee Section Establishes Student Loan Program

The Kentucky-Tennessee Section, SAF, has announced a program undertaken by that Section to encourage and assist forestry students through financial aid. Residents of Kentucky or Tennessee who are junior or senior students in an accredited forestry school

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Membership Applications and Advancements

Proposals for admission, advancement, and reinstatement received in the Society office during the month of February are listed below.

Action on the eligibility of those proposed for membership as listed below will be taken by the Council as of May 1959.

Communications from the voting members regarding the membership eligibility of these persons should be received in the Society office prior to that date.

Aikins, R. E. R.R. #1, Box 128, Weed, Calif. (Junior 1952; Member, **Northern California**).
Arment, C. R., 398 E. Second Ave., Chico, Calif. (Junior 1952; Member, **Northern California**).

Baggett, W. S. (Student, **API**).
Baker, G. E., Forester, Tieton Ranger Station, Naches, Wash. (Junior, **Puget Sound**).
Bailey, E. F. (Student, **Colo. State**).
Baldwin, M. S., P. O. Box 245, Vernon, Fla. (Junior 1952; Member, **Southeastern**).
Bartz, R. H. (Student, **Univ. Minn**).
Bawcom, R. H., Asst. Forest Tech., Calif. Div. of Forestry, Ft. Bragg, Calif. (Affiliate, **Northern California**).
Beaufait, W. R., Univ. of Mich., Ann Arbor, Mich. (Junior 1952; Member, **Wisconsin-Michigan**).
Beavers, J. R. (Student, **Mich. State**).
Beilmann, A. F., Dist. Forester, Mo. Cons. Comm., Eminence, Mo. (Junior 1955; Member, **Ozark**).
Benson, H. M., Forester, Perryville, Ark. (Affiliate, **Ozark**).
Blackwell, W. C. (Student, **API**).
Blunn, T. C. (Student, **Mont. State**).
Bolster, W. R., 2560 W. College Ave., Santa Rosa, Calif. (Junior 1952; Member, **Northern California**).
Brohn, P. D. (Student, **Mich. State**).
Brooke, R. C. (Student, **Yale**).
Brown, G. G. (Student, **Mont. State**).
Busby, F. M., Hammond Camp, Trinidad, Calif. (Junior 1952; Member, **Northern California**).
Buscher, R. F. (Student, **Ore. State**).
Bye, R. H. (Student, **Ore. State**).

Campbell, J. S. (Student, **API**).
Carlson, N. A., 331 Remington Ave., Thomasville, Ga. (Junior 1952; Member, **Southeastern**).
Carson, W. S. (Student, **W. Va. Univ.**).
Case, F. M., Fall Book Rd., Troy, Pa. (Junior 1952; Member, **Allegheny**).
Cayford, J. H., Forestry Officer, Fed. Forestry Branch, Winnipeg, Manitoba, Canada (Junior, **Upper Miss. Valley**).
Chapin, W. E., Asst. Nursery Supt., State Forest Nursery, Elkton, Ore. (Junior, **Columbia River**).
Coats, D. F. (Student, **Univ. Idaho**).
Collins, J. M., Unit Forester, International Paper Co., Eldorado, Ark. (Junior 1955; Member, **Ozark**).
Colvin, J. W., Forester, McKnight Veneers & Plywoods Inc., West Helena, Ark. (Affiliate, **Ozark**).
Crebbin, P. E., 1444 Hesket Way, Sac-

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ramento, Calif. (Junior 1952; Member, **Northern California**).
Creighton, D. G., Dist. Forester, Catawba Timber Co., Clinton, S. C. (Junior 1952; Member, **Appalachian**).
Crowell, B. R., Forester, Dept. of Forests & Waters, McConnelsburg, Pa. (Junior, **Allegheny**).

Davis, G. Northeastern Forest Expt. Station, Bangor, Maine (Junior 1952; Member, **New England**).
Deion, H. J., Deputy Chief, Div. of Forests, Cranston, R. I. (Junior 1952; Member, **New England**).
De La Puente E., J. M., Head, Forestry Dept., Chapingo, Mexico (Corresponding).
Denis, A. C., 130 E. Hill St., Amercus, Ga. (Rein. Junior 1954, **Southeastern**).
Dingus, B. J., Campton, Ky. (Junior 1952; Member, **Kentucky-Tennessee**).
Dinneen, W. R., Supv., Farm Service Foresters, Brigton, Maine (Junior 1952; Member, **New England**).
Doyle, L. M. (Student, **API**).
Drake, H. E., P. O. Box 62, Madison, Fla. (Junior 1952; Member, **Southeastern**).

Ebel, F. W. (Student, **Mont. State**).
Ellison, W. H. (Student, **Ore. State**).
Erdmann, G. G. (Student, **Mont. State**).
Eye, J. L. (Student, **W. Va. Univ.**).

Ferrell, G. T. (Student, **Univ. Calif**).
Fields, B. L. (Student, **Iowa State**).
Findell, V. E., Forester, Lake States Forest Expt. Station, St. Paul, Minn. (Rein. Junior 1951; **Upper Miss. Valley**.

Franson, J. E., Forest Supv., Warren, Pa. (Affiliate, **Allegheny**).
Frazier, J. L. (Student, **Univ. Idaho**).
Fuller, P. E., Forester, Oakmulgee Dist., Centreville, Ala. (Affiliate, **Southeastern**).

Gerhold, H. D., Instructor of Forestry, Pa. State Univ., Univ. Park, Pa. (Junior 1952; Member, **Allegheny**).
Getz, J. R., 1804 N. Broad St., Lansdale, Pa. (Junior 1952; Member, **Allegheny**).
Gottsacker, J. H. (Student, **Iowa State**).
Gresham, H. H., Working Circle Forester, St. Regis Paper Co., McIntosh, Ala. (Junior 1952; Member, **Southeastern**).
Gruber, J. M., Forestry Asst., Potlatch Forests, Inc., Lewiston, Idaho (Affiliate, **Inland Empire**).
Guerrero, W. A., Dist. Ranger, USFS, Williamsburg, Ky. (Junior 1955; Member, **Kentucky-Tennessee**).

Hailey, P. E. (Student, **Ore. State**).
Haissig, B. E. (Student, **Univ. Minn.**).
Hamilton, W. D., Forester, St. Regis Paper Co., Deferiet, N. Y. (Junior, **New York**).
Hanchell, F. G. (Student, **Univ. Calif**).
Handley, D. M., Forester, S. C. State Forestry Comm., Florence, S. C. (Affiliate, **Appalachian**).
Hauser, M. S. (Student, **Univ. Minn.**).
Heady, D. R. (Student, **State Univ., N. Y.**).
Heath, M. W., Vice President, Heath Survey Consultants Inc., Wellesley Hills, Mass. (Junior 1952; Member, **New England**).
Heinrich, S. L., Forester, Pope & Talbot, Inc., Port Gamble, Wash. (Junior 1955; Member, **Puget Sound**).
Henry, P. I., Crew Leader, Pomeroy & McGowin, Monticello, Ark. (Affiliate, **Ozark**).
Hill, A. L., Box 172, DeFuniak Springs, Fla. (Junior 1952; Member, **Southeastern**).
Hoke, B. G., Unit Forester, International Paper Co., Aiken, S. C. (Junior 1952; Member, **Appalachian**).
Holland, R. D., 5212 Yerkes St., Jacksonville, Fla. (Junior 1952; Member, **Southeastern**).
House, S. T., Resident Forester, Connwood Inc., Clayville, R. I. (Affiliate, **New England**).

John, H. H. (Student, **Univ. Minn.**).
Johnson, R. C. (Student, **Iowa State**).
Johnson, W. A., Axis, Ala. (Junior 1952; Member, **Southeastern**).
Jones, T. E., Service Forester, Va. Div. of Forestry, Salem, Va. (Affiliate, **Appalachian**).

Ingalls, A. E., Dist. Forester, Millinocket, Maine (Junior 1952; Member, **New England**).
Irwin, J. G. (Student, **Purdue**).

Kelley, E. L., Rt. 1, Box 483, Panama City, Fla. (Junior 1952; Member, **Southeastern**).
Koonce, K. M., Forester, Roy O. Martin Lumber Co., Alexandria, La. (Affiliate, **Gulf States**).
Krefting, L. W., Wildlife Research Biologist, U. S. Fish & Wildlife Service, St. Paul, Minn. (Rein. Junior 1947; **Upper Miss. Valley**).
Krieger, F. C., College of Home Economics, Univ. Park, Pa. (Student 1957; Junior, **Allegheny**).
Kuch, H. K., Box 17, Hoopa, Calif. (Junior 1952; Member, **Northern California**).

Lanner, R. M., Box 3176, Oroville, Calif. (Junior 1952; Member, **Northern California**).
Lara, F. W., Forester, Natl. Wildlife Federation, Washington, D. C. (Junior, **Washington**).
Lewis, D. K. (Student, **Univ. Minn.**).
Liimatta, I. M., Chief Forester, Alaska Lumber & Pulp Co., Inc., Sitka, Alaska (Junior 1954; Member, **Puget Sound**).
Lindsey, V. L., Forester, Nezperce Natl. Forest, Grangeville, Idaho (Affiliate, **Inland Empire**).
Little, M. L., Forester, USFS, Hector, Ark. (Affiliate, **Ozark**).
Lyche, W. D. (Student, **Ore. State**).

MacDonald, S. R. (Student, **Univ. Calif.**).
Macomber, E. E., Service Forester, Maine Forest Service, Brewer, Maine (Junior 1952; Member, **New England**).
Marple, W. L., Self Employed, Liberty, Maine (Junior 1952; Member, **New England**).
McBee, W. L. (Student, **W. Va. Univ.**).
McFrederick, J. W., Dist. Forest Ranger, Leadore Ranger Dist., Leadore, Idaho (Junior, **Intermountain**).
McIntyre, P. A. (Student, **State Univ. N. Y.**).
McKay, R. M. (Student, **Univ. Wash.**).
Mechem, J. (Student, **W.Va. Univ.**).

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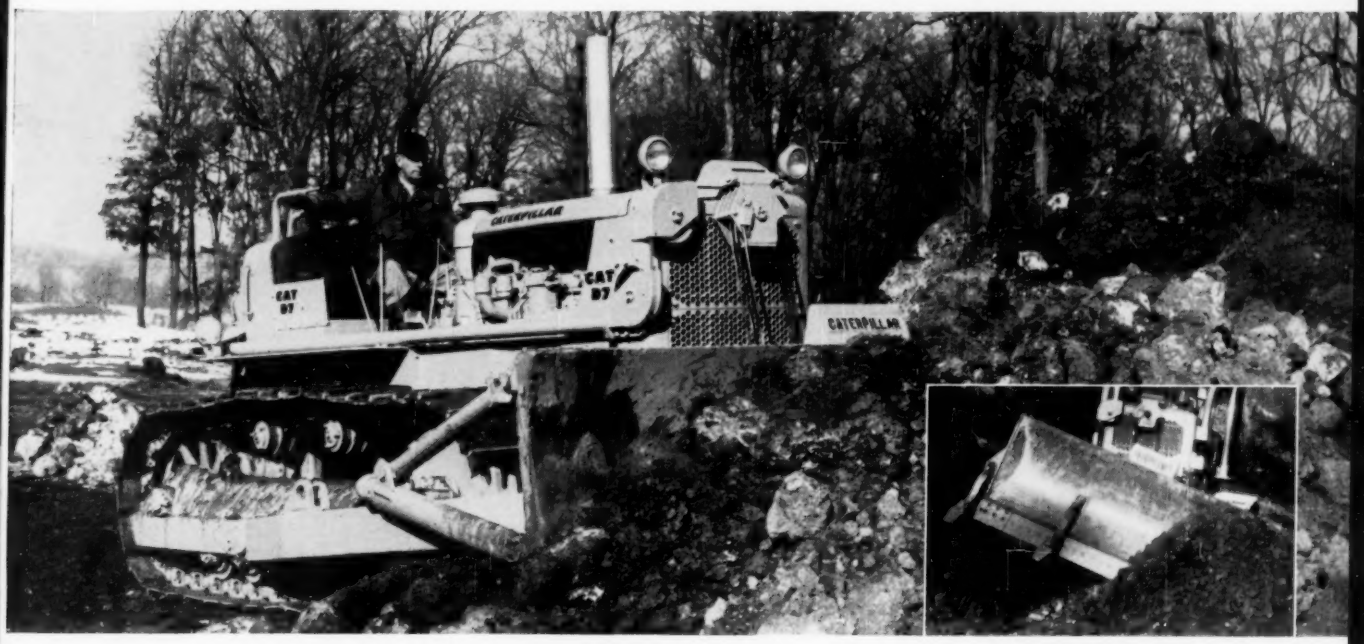

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Mergen, F., Asst. Prof., Yale School of Forestry, New Haven, Conn. (Junior 1952; Member, **New England**).
Meyer, A. (Student, **Ore. State**).
Miller, O., 2332 Northwood Terrace, Ann Arbor, Mich. (Junior 1952; Member, **New England**).
Mitchell, J. L. (Student, **Mont. State**).
Morgan, R. L., Habitat Development Leader, Bismarck, N. Dak. (Junior 1952; Member, **Upper Miss. Valley**).
Musbach, R. A., Resident Forester, Univ. Forest, Williamsville, Mo. (Junior 1955; Member, **Ozark**).

Naab, W. P., Forester, Wis. Cons. Dept., Tomahawk, Wis. (Junior 1953; Member, **Wisconsin-Michigan**).
Norris, T. L., Box 487, Madison, Fla. (Junior 1952; Member, **Southeastern**).
Nutter, G. W., Supt., Crown Zellerbach Corp., Molalla, Ore. (Affilitate, **Columbia River**).

Owens, R. O. (Student, **API**).

Paproke, K. M. (Student, **Ore. State**).
Parks, G. K., Asst. Dist. Ranger, Sierra Natl. Forest, Big Creek, Calif. (Junior 1955; Member, **Northern California**).
Parnell, R. W., Chip Program Coordinator, W. Va. Pulp & Paper Co., Charleston, S. C. (Affiliate, **Appalachian**).
Paulk, R. C. (Student, **Univ. Ga.**).
Paulsen, D. W. (Student. **Univ. Calif.**).
Payne, J. A. (Student, **Mont. State**).
Pennington, H. C., Field Mgr., Pomeroy & McGowin, Monticello, Ark. (Affiliate, **Ozark**).
Pitmon, W. C. (Student, **Purdue**).
Potter, R. V., Risch Ave., Butler, Pa. (Junior 1952; Member, **Allegheny**).
Puhn, W. J., Forest Supv., Sierra Natl. Forest, Fresno, Calif. (Junior 1955; Member, **Northern California**).

Raborn, W. W., 1525 Sommerville Rd., Jacksonville, Fla. (Junior 1952; Member, **Southeastern**).
Radford, A. L., Rome Kraft Co., Elberton, Ga. (Junior 1952; Member, **Southeastern**).
Raymond, E. W., 25 Vermont Ave., Dracut, Mass. (Junior 1952; Member, **New England**).
Rennie, R. L. (Student, **Univ. Calif.**).
Robert, K. P., Asst. Dist. Forester, Wis. Cons. Dept., Madison, Wis. (Affiliate 1957; Junior, **Wisconsin-Michigan**).
Roberts, V. D., Forest Mgr., Selma Timber Co., Selma, Ark. (Affiliate, **Ozark**).
Rogers, C. S., Asst. Area Forest Supt., International Paper Co., Pine Bluff, Ark. (Affiliate, **Ozark**).
Rogers, M. H. (Student, **Univ. Ga.**).
Rucker, J. S., Wood Tech., State College of Wash., Pullman, Wash. (Affiliate, **Inland Empire**).

Sampson, O. R. (Student, **API**).
Schrenk, G. M., 1107 N. Calhoun St., Perry, Fla. (Junior 1952; Member, **Southeastern**).
Shain, W. E. (Student, **Colo. State**).
Shepherd, J. N. (Student, **API**).
Shiue, C. J., Asst. Prof., Univ. of Minn., St. Paul, Minn. (Junior, **Upper Miss. Valley**).
Shreve, L. W., Asst. Dist. Forester, Ky. Div. of Forestry, Mayfield, Ky. (Junior 1955; Member, **Kentucky-Tennessee**).
Smith, D. P., P. O. Box 188, Panama City, Fla. (Junior 1952; Member, **Southeastern**).
Smith, J. H., Box 521, Ocala, Fla. (Junior 1952; Member, **Southeastern**).
Smith, W. C. (Student, **Univ. Ga.**).
Snodgrass, B. K., Dist. Forester, Dierks Forests Inc., Umpire, Ark. (Affiliate, **Ozark**).
Spencer, D. L., Wildlife Reforestation Supv., Kenai, Alaska (Junior, **Puget Sound**).
Stafford, J. L., P. O. Box 37, Lee, Fla. (Junior 1952; Member, **Southeastern**).
Stancel, P. A. (Student, **Mich. State**).
Steiro, K. O. (Student, **Univ. Minn.**).
Stephens, G. R., Graduate Student, Yale Graduate School, New Haven, Conn. (Junior 1952; Member, **New England**).
Sterling, J. J., Forester, W. T. Carter & Brother, Camden, Texas (Affiliate, **Gulf States**).
Stoops, R. R. (Student, **Mont. State**).
Sullivan, J. D., Asst. Prof. Duke Univ., Durham, N. C. (Junior, **Appalachian**).
Sumner, D. K., 916 Chestnut St., Mifflinburg, Pa. (Junior 1952; Member, **Allegheny**).

Thayer, H. A. (Student, **Duke**).
Thompson, B. O. (Student, **API**).
Thompson, L. S., Forester, Mich. State Highway Dept., Detroit, Mich. (Junnor 1952; Member, **Wisconsin-Michigan**).
Tiller, E. J., 425 Palo Alto, Panama City, Fla. (Junior 1952; Member, **Southeastern**).
Timmers, F. A., 1222 Everett St., El Cerrito, Calif. (Junior 1952; Member, **Northern California**).
Tobiaski, R. A., USFS, Vicksburg, Miss. (Junior 1952; Member, **Gulf States**).
Tutton, T. A., Box 1073, Jackson, Calif. (Junior 1952; Member, **Northern California**).

Utter, O. W. (Student, **API**).
Utterback, R. C. (Student, **Univ. Calif**).

Van Kleeck, R. T., 3030 Sacramento Dr., Redding, Calif. (Junior 1952; Member, **Northern California**).
Vaughn, J. E. (Student, **Duke**).
Verner, R. S., Forester, Targhee Natl. Forest, St. Anthony, Idaho (Junior, **Intermountain**).

Waddell, H. T., N. Garden Apts., Doylestown, Pa . (Junior 1952; Member, **Allegheny**).
Walker, W. W., Gen. Delivery, Soperton, Ga. (Junior 1952; Member, **Southeastern**).
Walkup, R. H., Forester, Crown Zellerbach Corp., Molalla, Ore. (Junior, **Columbia River**).
Wallace, D. R., Ext. Forest Products Mkt. Specialist, Agric. Ext. Service, Little Rock, Ark. (Junior 1955; Member, **Ozark**).
Watkins, F. G., 120 Bishop St., New Haven Conn. (Student 1957; Junior, **New England**).
Webb, C. H., P. O. Box 723, Sylacauga, Ala. (Junior 1952; Member, **Southeastern**).
Webster, H. H., Northeastern Forest Expt. Station, Upper Darby, Pa. (Junior 1952; Member, **Allegheny**).
Wetzel, A. G. (Student, **Univ. Fla.**).
Wheeler, W. H., 325 E. High St., Ebensburg, Pa. (Junior 1952; Member, **Allegheny**).
Widder, J. J., Asst. Dist. Forester, Dodgeville State Bank Bldg., Dodgeville, Wis. (Junior, **Wisconsin-Michigab**).
Williams, O. L., 48 Arrow Head Dr., Cartersville, Ga. (Junior 1952; Member, **Southeastern**).
Willis, R. O., Asst. Mgr., St. Marys Kraft Corp., St. Marys, Ga. (**Junior** 1952; Member, **Southeastern**).

Youker, J. C. (Student, **Iowa State**).

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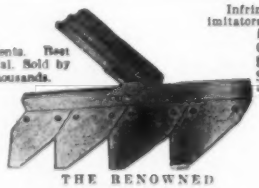
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Forestry News

International Botanical Congress

The Ninth International Botanical Congress will be held in Montreal, Canada, August 19-29, 1959, at the University of Montreal, McGill University and Sir George Williams College.

The first session of the International Botanical Congress was held in Brussels in 1864. It has been held only once before on this continent, in the U. S. About 6,000 delegates from 72 countries are expected to attend.

The program of the scientific sessions will be conducted in 16 sections and will deal with all aspects of botany in its broadest sense, including plant production, breeding, and protection and their implications for agriculture and forestry. Some 400 selected leading scientists representing all sections of the program have been invited to present papers, participate in symposia and give public lectures. About 2,000 contributed or voluntary papers will also be given.

An extensive series of field trips constitutes an important part of the Congress. Seventeen pre-Congress field trips and 7 post-Congress field trips have been organized, covering the period July 20 to September 14.

Forest Battle Tames Budworm

Industry and government foresters convening in Portland, Ore. for the recent tenth anniversary meeting of the Northwest Forest Pest Action Council totted up a striking success in spruce budworm control, but foresaw a hard battle ahead to salvage blowdown timber and reduce damage to trees from animals and other insects and diseases.

The council adopted a resolution calling on Congress to give high priority to providing funds for basic research on Northwest forest insect and disease problems. It asked for more laboratory facilities in this area for that purpose.

The group was told that the spruce budworm, which once threatened destruction of some 4.5 million acres of timber in Oregon, has now been eliminated as a serious present threat.

The foresters warned that last fall's high windstorms in Washington blew down or broke off enough timber to raise serious danger of another spreading Douglas-fir bark beetle infestation similar to the one caused by high winds in Oregon in 1951.

Cleanup of this earlier blowdown damage has not yet been completed, and bark beetles currently infest some 880,000 acres in Oregon and 31,300 acres in Washington. The council urged rapid salvage and reactivated its Douglas Fir Bark Beetle Committee to facilitate this.

Various other forest pest and disease problems were discussed.

E. L. Kolbe, chief forester for Western Pine Assn., Portland, was reelected chairman of the council. The group presented him with a bronze plaque honoring his record of service as chairman since incepton of the council a decade ago.

H. R. Glascock, Portland, forest counsel of Western Forestry and Conservation Assn., was elected vice-chairman, succeeding Royce Cornelius, managing forester for Weyerhaeuser Timber Co., Tacoma, Wash. Norman E. Bjorkland, Industrial Forestry Assn., Portland, was reelected secretary.

Francis W. Sargent Heads Recreation Review Commission

Francis W. Sargent has been selected as executive director of the professional staff of the Outdoor Recreation Resources Review Commission. He took office on March 1. A graduate of M.I.T., he has for the past two years been commissioner of the Massachusetts Department of Natural Resources. Prior to that he was attached to the Massachusetts Marine Fisheries Commission.

Senators Dworshak (Ida.) and Martin (Ia.) have been named as members of the O.R.R.R.C. by Vice-President Richard M. Nixon. They replace Arthur V. Watkins and Frank A. Barrett, who were defeated for reelection last fall.

Other congressional members of the 15-person bi-partisan Commission are: Senators Anderson (N.M.) and Neuberger (Ore.) and Representatives Saylor (Pa.), Ullman (Ore.), Pfost (Ida.) and Collier (Ill.).

The seven citizen members of the Commission include two professional foresters: Samuel T. Dana and Bernard L. Orell.

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The Commission is to report its findings on current and future recreational needs to Congress in 1961.

N. W. Forest Soils Council Elects Ted Yocum as New Chairman

T. R. Yocum of Simpson Logging Company, Seattle, Wash., was elected chairman of the Northwest Forest Soils Council at the winter meeting held in the Interior Building at Portland Ore. on February 13. He replaces George Schroeder, chief forester of Crown Zellerbach Corporation who served several years as head of this forestry group. Royce Cornelius, managing forester of Weyerhaeuser Timber Company, one of the charter members of the original committee, requested that he be relieved of membership due to increased responsibilities. The council recorded a resolution of commendation for the outstanding work of these two foresters in furthering forest soils work in the Northwest.

Various council members reported on research work under way in the fields of forest soils research and surveys.

Of special interest to field foresters is assistance being made available by the council in promotng meetings and field trips with a theme of forest soils. Chairman Yocum urged local SAF Chapters to plan panel discussions and field trips to highlight forest soil problems and activities.

The summer field meeting will be held

OFFICERS OF THE Fifth World Forestry Congress. *L* to *R*, Henry Schmitz, honorary vice chairman of the Congress; V. L. Harper, vice chairman; Richard E. McArdle, chairman; and I. T. Haig, executive secretary.

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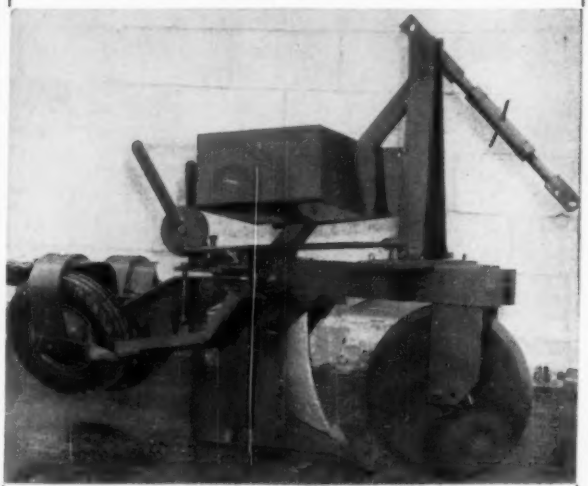

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Members of the Organizing Committee for the Fifth World Forestry Congress, photographed January 13 in Washington, D. C.

June 18 and 19 in the Okanagan-Wenatchee area where soil survey techniques and watershed management problems will be observed and studied.

Kerr Appointed to Association Post

Ed Kerr, press representative for the Louisiana Forestry Commission for the past eight years, has been appointed assistant executive director of the Louisiana Forestry Association, it has been announced by Vertrees Young, president of the association. He will assist J. H. Kitchens, Jr., executive director, with headquarters in Alexandria.

Private & Industrial

Weyerhaeuser Foresters Promoted

The appointment of three Weyerhaeuser Timber Company foresters to management jobs was recently announced.

D. Nelson Jeffers, branch forester at Longview, Wash., has been named staff forester at the company's headquarters in Tacoma, E. F. Heacox, manager, timberland department, stated.

Howard W. Millan, branch forester of the White River tree farm near Enumclaw, will succeed Jeffers at Longview.

Stanley E. Olson will advance from assistant branch forester to branch forester for the White River Branch.

In the newly-created position, Jeffers will assist Royce O. Cornelius, company managing forester, in coordinating forestry activities on the company's 13 tree farms. A University of Idaho forestry graduate, he joined Weyerhaeuser in 1943 and was appointed Longview branch forester in 1948.

As branch forester at Longview, Millan will be responsible for the forestry program on the firm's largest tree farm—the 514,962-acre Mt. St. Helens unit. Millan has been branch forester at the White River tree farm since 1947 and began working with the company 15 years ago. He is a University of Washington graduate.

Olson steps into his new position after being assistant branch forester for eight years. In this capacity he handled contract logging. His new position makes him responsible for all forestry activities on the White River tree farm. Olson graduated from the University of Minnesota.

St. Regis Names Woodlands Manager

St. Regis Paper Company announces the appointment of Frank A. Albert as manager of lands and forests for the company's woodlands in the South. The announcement was made through the office of Albert Ernest, St. Regis vice president in charge of southern

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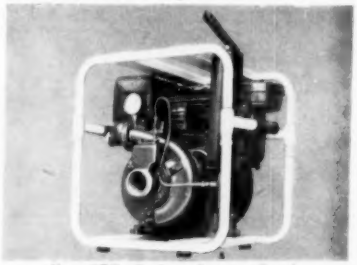

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woodlands, and is part of a reorganization of the company's woodlands organizations reflecting the steady expansion of St. Regis' operations in the South.

Mr. Albert most recently served as director of the Georgia Forest Research Council. He is a graduate forester from Penn State University, and retired in 1957 from the U. S. Forest Service after 30 years of service, principally in the South. Mr. Albert will make his headquarters in Jacksonville, Fla.

Marcus G. Rawls has been named manager of wood procurement and land acquisition for St. Regis southern woodlands, serving St. Regis mills in Jacksonville and Pensacola, Fla. Mr. Rawls is a graduate of the University of Florida and joined St. Regis in 1948. His headquarters are in Jacksonville.

Joseph M. Brewster has been appointed assistant manager of wood procurement and land acquisition for St. Regis southern woodlands in the Pensacola area. Mr. Brewster joined the company in 1947 and has been serving as woodlands manager at the company's Pensacola mill. He will continue to make his headquarters in Pensacola.

Johnson Honored by Virginia Forests, Inc.

James H. Johnson, chief forester of The Chesapeake Corporation of Virginia, was named "Man of the Year" in Virginia forestry at the annual meeting of Virginia Forests, Inc., at Roanoke on February 3.

Johnson was cited for pioneering in educational and public relations programs through conservation-minded county forestry committees, and for developing a technique of bulldozing to encourage loblolly pine growth and eliminate unprofitable hardwoods in Virginia.

A native of Virginia, Johnson graduated from Washington and Lee University in 1936. He had two years' graduate work at V.P.I. in geology in 1937-1938 and obtained his master's degree in forestry at Yale in 1940.

He became assistant forester for The Chesapeake Corporation in 1940 and chief forester five years later.

Heads Seaboard Co. Department

Seaboard Lumber Co., Seattle, Wash., has announced the promotion of Donald E. Dyson to vice-president, Timber and Log Department. Dyson, a graduate of the College of Forestry, University of Washington, joined Seaboard in 1947. Before that, he had been with Bloedel, Stewart & Welch as resident forester at Franklin River, B. C.

Continental's Woodlands Section to Grant Scholarship

Continental Can Company's Woodlands District, Hodge, La., will continue its program of annually providing a forestry scholarship totaling $4,000.

The scholarship is to be granted to an outstanding high school graduate from the portion of Louisiana or Arkansas where the company operates or owns timberlands and is an extension of the overall forestry scholarship program of Continental Can Company in North Carolina, Virginia, South Carolina, Georgia, and Florida where its woodlands departments also operate.

The successful applicant will be permitted to indicate his preference to attend Louisiana State University or Louisiana Polytechnic Institute.

Gair Woodlands Corporation Again Offers Scholarships

Gair Woodlands Corporation, Savannah, Ga., has announced that it will continue its scholarship program of annually providing two forestry scholarships. Each scholarship totals $4,000 which is an increase of $2,000 over previous years, to cover the increased cost of living. Each scholarship is for $1,000 per year for four years of study in the field of professional forestry.

This is the sixth consecutive year the corporation has offered these scholarships to outstanding high school graduates in states where the corporation operates or owns timberlands.

The succesful applicants will be permitted to indicate their preference to attend the Forestry School of the University of Georgia, University of Florida, North Carolina State College, or Clemson Agricultural College.

Over 600 Attend S. C. Wood Demonstration

Two new mechanical tree planters, made possible through donations by the banks of Florence and Darlington County, S. C., were given to the small woodland owners at a woods demonstration sponsored by the Seaboard Air Line Railroad Company. More than 600 persons attended the demonstration held at the City Airport property near Florence on January 30.

Congressman John L. McMillan, a ranking member of the Agricultural Committee and also Chairman of the Subcommittee on Forestry, delivered the principal address.

Directing the program was Robert N. Hoskins, general forestry agent for the Seaboard Railroad. The demonstration brought together representatives of state, federal, industrial, and business organizations in a program accenting wood utilization and the small woodland owner.

Philippine Forester Begins Consulting Work

Valentin Sajor has begun work as a consulting forester and grazing consultant in Manila, the Philippines, following his retirement as assistant chief of the Forest Research Division, Bureau of Forestry, Manila, in October 1958.

Mr. Sajor has worked in Philippine forestry for more than 43 years.

After receiving a ranger's certificate from the College of Forestry, University of the Philippines, he came

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THOMAS (TOM) C. CLIFTON

to the United States to study. He received a B.S.F. degree from the University of Idaho in 1926 and an M.F. from Yale in 1927.

He is a member of the SAF and the American Society of Range Management.

Schools

Dubuar Visiting Professor at Southern Illinois

James F. Dubuar, Earlville, N. Y., is serving as visiting professor of forestry at Southern Illinois University, Carbondale, for the spring term. Prof. Dubuar directs Southern's spring term forestry camp program, which began March 16.

Dubuar retired last summer as director of the State Ranger School in the University of New York College of Forestry, a position he had held since 1921. He joined the faculty there as professor of forestry in 1919 after two years with the U. S. Forest Service.

C. S. Herr 1959 Greeley Lecturer in Industrial Forestry

The University of Washington College of Forestry has announced that C. S. Herr, vice president of The Brown Company of Berlin, N. H., has served as the 1959 Colonel William B. Greeley Lecturer in Industrial Forestry. Mr. Herr presented a series of three lectures on the development of industrial forestry in the northeastern states on February 26, 27, and 28.

Mr. Herr was the third speaker in the industrial forestry lecture series. In 1957 the first speaker was Axel Brandstrom, a consulting forester, who spoke on the development of industrial forestry in the Pacific Northwest. The lectures in 1958 were presented by Frank Heyward, of the Gaylord Container Corporation of Bogalusa, La., on the development of industrial forestry in the southern states.

Appointed to University of Washington Staff

Robert K. Campbell and Kenneth J. Turnbull have recently been appointed as instructors on the staff of the College of Forestry at the University of Washington.

Dr. Campbell graduated from Montana State University in 1951, receiving a BA degree in botany. In 1954 he received his MS degree in genetics from the University of Washington and his doctorate in forestry at the University of Washington in 1958. From 1956 to 1958 he served as forest geneticist for the Industrial Forestry Association, working both in the states of Washington and Oregon. He will conduct classes and research work in the fields of forest genetics and silviculture.

Mr. Turnbull, who will teach classes in forest economics and mensuration, received his undergraduate training in civil engineering and forestry at the University of Edinburgh, Scotland, graduating in 1951. He received his master's degree in forestry from the University of Washington in 1958 and has completed all of the requirements for the Ph.D. degree in forestry except for the completion of his thesis. In addition to experience in Scotland and Norway, he has worked for the Washington State Division of Forestry in various capacities.

Wilde Honored by Finnish Foresters

S. A. Wilde, professor of soils at the University of Wisconsin, has been elected to honorary membership by the Society of Forestry in Finland.

The Society cited Professor Wilde's "valuable scientific work . . . in the field of Forestry" and his interest in and friendliness to "Finnish Forestry and its representatives."

Wisconsin Expands Graduate Study in Forest Products

An expanded program of graduate study in the field of forest products, providing paid research fellowships and assistantships to candidates for M.S. and Ph.D. degrees, will be offered at the University of Wisconsin during the academic year starting in September.

Several research posts will be available to applicants, according to an announcement from the graduate school of the University. Those receiving appointments will do research at the U. S. Forest Products Laboratory.

Appointees will be paid up to $2,000 for the academic year, and there will be opportunities for summer employment at the laboratory, according to Dr. J. A. Hall, director.

Assistantships will be available in the fields of civil, mechanical, and chemical engineering, chemistry, biochemistry, botany, and plant pathology. The program is administered by a joint committee representing the university faculty and the Forest Products Laboratory staff.

Candidates for the assistantships

can obtain further information and enrollment blanks from Professor W. K. Neill, 3218 Chemical Engineering Building, University of Wisconsin, Madison or from Director J. A. Hall, Forest Products Laboratory, Madison.

Symposium, Short Course Scheduled in North Carolina

Both Duke University, Durham, N. C., and North Carolina State College, Raleigh, have announced plans for brief training sessions in forestry this spring.

On April 21-22 a "Forestry Symposium on Direct Seeding in the South" will be held on the Duke campus. Representatives of industry, the U. S. Forest Service and other government agencies, colleges and universities, as well as consultants and forest landowners have been invited to participate. The program will include technical addresses and panel discussions.

At North Carolina State College a short course, "Forest Genetics and Its Application to Forest Management," will be offered June 8-10. The course is designed to demonstrate to the practicing forester principles of inheritance which he can use as a silvicultural tool. Field trips are planned to supplement classroom instruction.

Inquiries concerning the courses should be addressed to the respective schools.

Public

National Park Service Reports 58,677,000 Visitors in 1958

Travel to the 29 national parks and 150 other areas administered by the National Park Service totaled 58,677,000 in 1958, the Department of the Interior reports.

The total was off 608,000 or 1 percent from the 59,285,000 recorded in the previous year. The 1957 total, however, included more than 900,000 visitors to the Millerton Lake Recreation Area in California, whose administration was transferred to the State of California in November of that year and therefore was not included in the 1958 Park Service visitor count.

Despite the 1 percent drop in the over-all total, travel to national parks, monuments, and parkways—representing 115 of the 179 units covered in the report—continued to break all records in 1958, Park Service Director Conrad L. Wirth said.

Visitors to the 29 national parks rose to 21,672,000 during the year, a 3.7 percent increase over the record 1957 total of 20,903,000. The 83 national monuments reported a total of 9,734,000 visitors, up 4.1 percent from the total of 9,351,000 in the previous year. Two of the three national parkways — Blue Ridge, Virginia-North Carolina, and Natchez Trace, Mississippi - Alabama - Tennessee — reported 8,130,000 visitors, an increase of 3.1 percent from the total of 7,890,000 in 1957. Use of the third national parkway—George Washington Memorial, Virginia-Maryland—is not recorded.

Lower visitor totals were reported for the 59 national historical areas and the four national recreation areas. Visitors to the historical areas numbered 13,913,000, a 10 percent drop from the 15,453,000 of 1957. The four national recreation areas counted 5,065,000 visitors in 1958, a 9 percent drop from the 5,559,000 of 1957. The one national memorial park—Theodore Roosevelt in North Dakota—had 163,000 visitors, a 27 percent gain over the 129,000 of 1957.

A. L. Nelson Leaves Forest Service Post

Arthur L. Nelson retired December 31 as assistant regional forester in charge of the Division of Timber Management, Rocky Mountain Region of the Forest Service. He had held the position for 14 years.

In 1923 Mr. Nelson received his first Forest Service assignment and went to the Bighorn National Forest in Wyoming. After that he moved to national forests in South Dakota, Nebraska, Georgia, Arkansas, and Colorado. In 1950 he took charge of a program to combat the Engelmann spruce bark beetle in Colorado.

Mr. Nelson, a native of Minneapolis, Minn., is a graduate of the University of Minnesota. He served two terms each as chairman of the Rocky Mountain and Ozark Sections of the SAF.

Heaton to Recreation Study Post

Philip L. Heaton, since 1956 chief, Branch of Recreation and Land Uses for the Rocky Mountain Region of the U. S. Forest Service, is being transferred to Washington to head up the national forest phase of the Outdoor Recreation Resources Review called for by legislation enacted by Congress last year.

Robert W. Gardner, supervisor of the Routt National Forest at Steamboat Springs, Colo., will succeed Heaton in the Denver Office.

Regional Forester Donald E. Clark

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PHILIP L. HEATON

stated that the transfers would be effective about April 1.

A graduate of Colorado State University, Heaton was previously supervisor of the Bighorn National Forest. In 1947 and 1948 he was on special assignment to the War Department as forestry advisor in Korea.

Gardner graduated from the University of California in 1935. He has been supervisor of the Routt since 1956.

Gruschow Joins Central States as Station Manager

George F. Gruschow has been appointed to a newly created station manager position at the Central States Forest Experiment Station of the U. S. Forest Service, W. G. McGinnies, director of the Station, has announced. Transferring from the Southeastern Station where he was a research center leader, Gruschow assumed his new duties in Columbus, Ohio in February.

Except for 4½ years in the Army as commander of a forestry company in Europe and the Philippines during World War II, he has been with the Southeastern Station since 1940.

Station Management Post at Lake States Filled

The appointment of James E. Sowder as chief of the Division of Station Management of the Lake States Forest Experiment Station has been announced by M. B. Dickerman, station director.

Mr. Sowder was transferred from the position of leader of the Bend, Oregon, research center of the Pacific Northwest Forest and Range Management Station, a position he had held since 1949. He was first employed by the Forest Service in 1932. After three years with the California Forest and Range Experiment Station he transferred to the U. S. Indian Service in Oregon. Two years later he returned to the Forest Service in California, with the administrative branch. He worked on the Tahoe National Forest until 1939 on the Modoc from 1939 to 1949.

Sowder received his forestry training at the University of Idaho and served in the U. S. Navy from June 1943 to November 1945.

Forestry Employment

S.A.F. members are privileged to insert one 60-word advertisement in this column without charge. Forest industries desiring to employ foresters may insert advertisements at the rate of $4 per column inch. Copy must be received by the end of this month for an advertisement to appear in the issue after next.

Obviously the Society cannot assume responsibility beyond making it possible for prospective employee and employer to enter into negotiations.

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Positions Wanted

Forester, B.S. 1950, M.F. in Forestry Economics expected June 1959. Age 34, married, one child. Experience: Six years state farm forestry program; two years with paper company in acquisition and management of timberlands. Prefer position in industrial woodland management.

Box E, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, B.S., Pa. State, 1954. Experience: Three years, U. S. Department of Agriculture (Forest Service and Soil Conservation Service); road location, forest inventory, T.S.I., erosion control, drainage, soil improvement, relations, and administration. Practical experience, farm woodlands, landscaping, and nurseries. Air Force intelligence officer two years. Northeast, Lake States, or Canada preferred.

Box F, Journal of Forestry, Mills Building, Washington 6, D. C.

Master's degree in forestry 1956. Age 29, married, veteran. Experience: In charge of photo interpretation inventory and mapping of ½ million acres of industrial forest, familiar with I.B.M. inventory procedures and planning. Revision and construction of management plans and associated records. Familiar with stumpage appraisal, depletion, and tax problems in industrial forestry. Present position Consultant. Desire new association as consultant or responsible position in industrial management.

Box G, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, B.S., 1957, Penn. State Univ. Age 24, married, no children. Soon to be discharged from military obligation. Three summers experience with U.S.F.S. in Oregon and California. Desire position offering opportunity for advancement. Will consider any locality except Southeast.

Box H, Journal of Forestry, Mills Building, Washington 6, D. C.

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Ask your IH dealer to demonstrate all the outstanding features of the International 240—as well as the even more rugged 340 and 460 Utility logging tractors. There's an IH dealer near you. Call him today! For free catalog, write International Harvester Company, Dept. JF-4, P. O. Box 7333, Chicago 80, Illinois.

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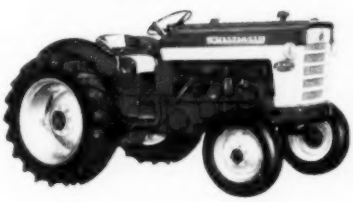

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